FINAL REPORT

I-40 West Corridor Profile Study

California State Line to Junction I-17

PREPARED FOR ADOT MARCH 2017

ADOT WORK TASK NO.
MPD 072C-14

ADOT CONTRACT NO.
11-013152

Prepared by

Kimley»Horn

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ARIZONA DEPARTMENT OF TRANSPORTATION

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IN ASSOCIATION WITH:

CAMBRIDGE SYSTEMATICS

This report was funded in part through grants from the Federal Highway Administration, U.S. Department of Transportation. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data, and for the use or adaptation of previously published material, presented herein. The contents do not necessarily reflect the official views or policies of the Arizona Department of Transportation or the Federal Highway Administration, U.S. Department of Transportation. This report does not constitute a standard, specification, or regulation. Trade or manufacturers' names that may appear herein are cited only because they are considered essential to the objectives of the report. The U.S. government and the State of Arizona do not endorse products or manufacturers.

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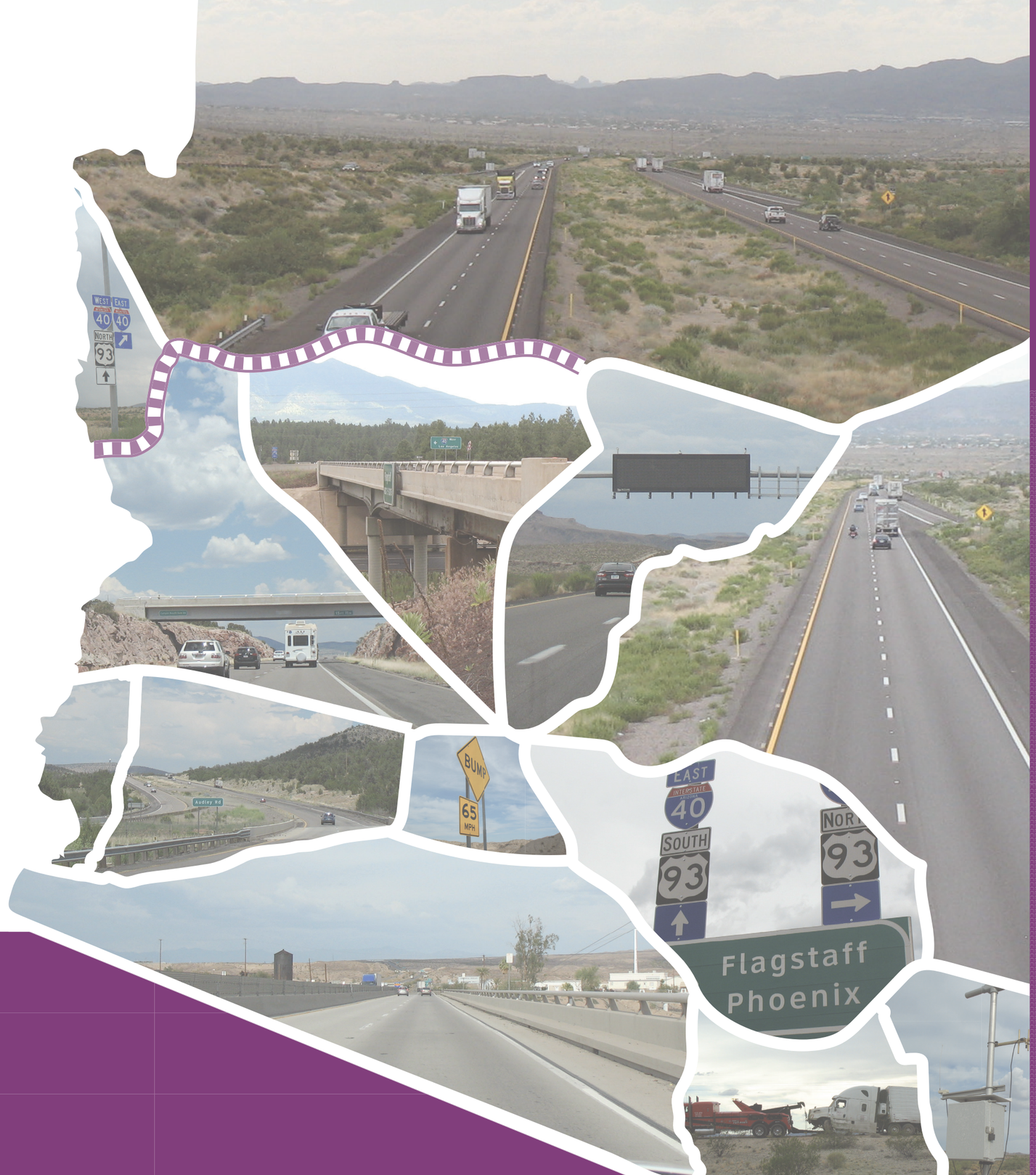
ACRONYMS & ABBREVIATIONS

AADT	Average Annual Daily Traffic
ABISS	Arizona Bridge Information and Storage System
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
ASLD	Arizona State Land Department
AZTDM	Arizona Statewide Travel Demand Model
BLM	Bureau of Land Management
BNSF	Burlington Northern Santa Fe
BQAZ	Building a Quality Arizona
CCTV	Closed Circuit Television
CR	Cracking Rating
DCR	Design Concept Report
DMS	Dynamic Message Sign
EB	Eastbound
ECoNA	Economic Collaborative of Northern Arizona
FHWA	Federal Highway Administration
FMPO	Flagstaff Metropolitan Planning Organization
FY	Fiscal Year
HCRS	Highway Condition Reporting System
HERE	Real time traffic conditions database produced by American Digital Cartography Inc.
HPMS	Highway Performance Monitoring System
I	Interstate
IRI	International Roughness Index
ITS	Intelligent Transportation System
LCCA	Life-Cycle Cost Analysis
LOS	Level of Service
LRTP	Long-Range Transportation Plan
MAP-21	Moving Ahead for Progress in the 21st Century
MP	Milepost
MPD	Multimodal Planning Division
NACOG	Northern Arizona Council of Governments
NAU	Northern Arizona University
NB	Northbound
NCFRP	National Cooperative Freight Research Program
NPV	Net Present Value
OP	Overpass
P2P	Planning-to-Programming
PA	Project Assessment
PAG	Pima Association of Governments
PARA	Planning Assistance for Rural Areas
PDI	Pavement Distress Index
PES	Performance Effectiveness Score
POE	Port-of-Entry
PS	Prioritization Score
PSR	Pavement Serviceability Rating
PTI	Planning Time Index
RTP	Regional Transportation Plan
RWIS	Road Weather Information System
SATS	Small Area Transportation Study
SB	Southbound
SCAG	Southern California Association of Governments
SERI	Species of Economic and Recreational Importance
SGCN	Species of Greatest Conservation Need
SHCG	Species and Habitat Conservation Guide
SHSP	Strategic Highway Safety Plan
SOV	Single Occupancy Vehicle
SPUI	Single Point Urban Interchange

SR	State Route
STB	Surface Transportation Board
STIP	State Transportation Improvement Program
SWAP	State Wildlife Action Plan
TAC	Technical Advisory Committee
TI	Traffic Interchange
TIP	Transportation Improvement Plan
TPTI	Truck Planning Time Index
TTI	Travel Time Index
TTIS	Travel and Tourist Information System
TTTI	Truck Travel Time Index
UP	Underpass
USDOT	United States Department of Transportation
V/C	Volume-to-Capacity Ratio
VMT	Vehicle-Miles Travelled
VPD	Vehicles per Day
VSL	Variable Speed Limit
WACOG	Western Arizona Council of Governments
WB	Westbound
WIM	Weigh-in-Motion



Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of the western portion of Interstate 40 (I-40) between the California State Line and Interstate 17 (I-17). This study examines key performance measures relative to the I-40 West corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT is conducting eleven CPS within three separate groupings. The I-40 West corridor, depicted in **Figure ES-1**, is one of the strategic statewide corridors identified and the subject of this CPS.

Corridor Study Purpose, Goals and Objectives

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

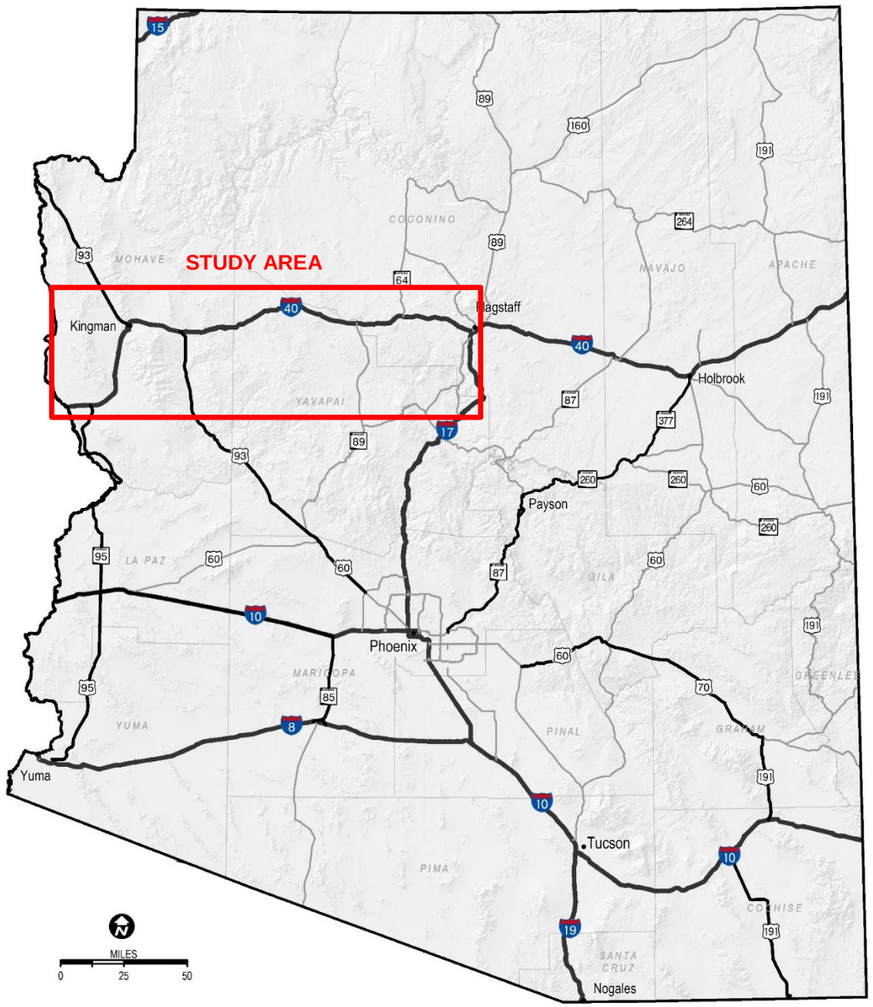
- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-40 West CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance.

The following goals are identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

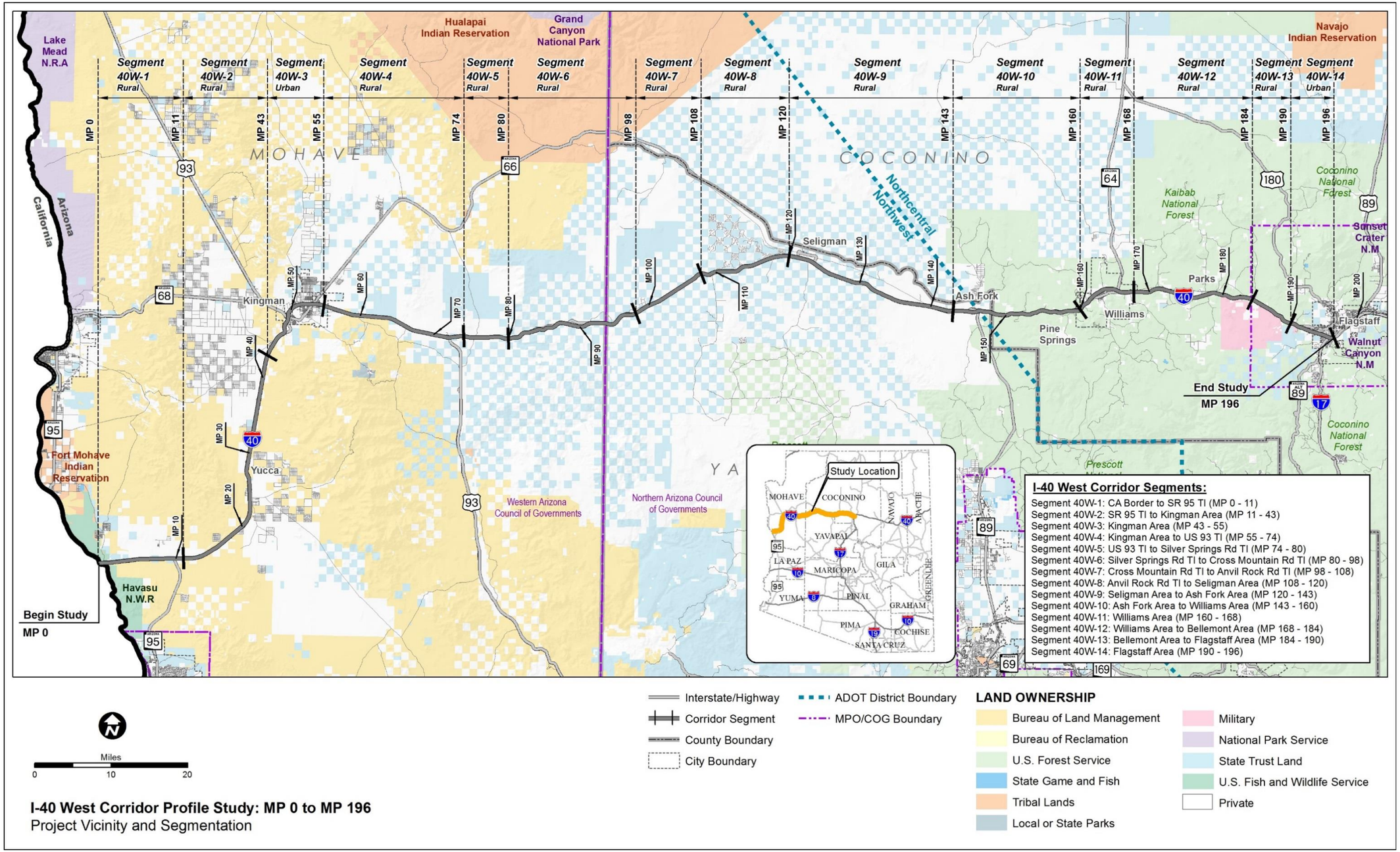
Figure ES-1: Corridor Study Area



Study Location and Corridor Segments

The I-40 West corridor is divided into 14 planning segments for analysis and evaluation. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are shown in **Figure ES-2**.

Figure ES-2: Corridor Location and Segments



I-40 West Corridor Profile Study: MP 0 to MP 196
Project Vicinity and Segmentation

CORRIDOR PERFORMANCE

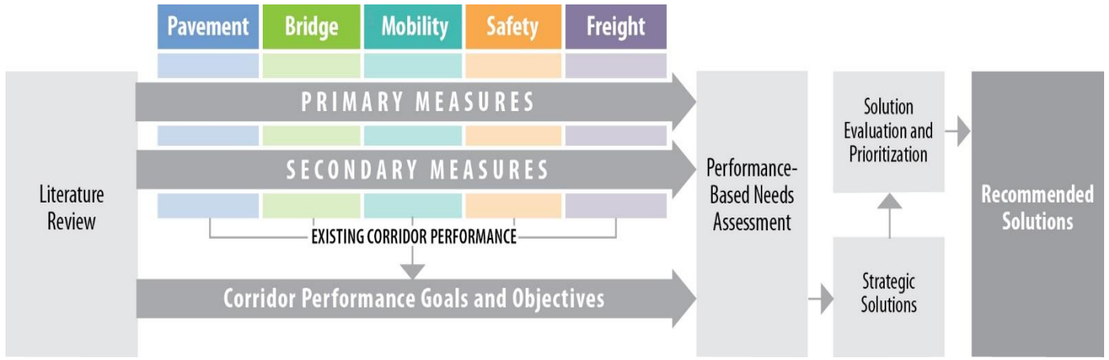
A series of performance measures is used to assess the I-40 West corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure ES-3 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance.

Figure ES-3: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance. **Table ES-1** provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table ES-1: Corridor Performance Measures

Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

Each of the primary and secondary performance measures identified in the table above is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating is within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

The terms “good”, “fair”, and “poor” apply to the Pavement, Bridge, Mobility, and Freight performance measures, which have defined thresholds. The terms “above average”, “average”, and “below average” apply to the Safety performance measures, which have thresholds referenced to statewide averages.

Corridor Performance Summary

Table ES-2 shows a summary of corridor performance for all primary measures and secondary measure indicators for the I-40 West corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure as shown in **Table ES-2**.

Based on the results of the performance evaluation, the following general observations were made related to the performance of the I-40 West corridor:

- Overall Performance: The Pavement, Mobility, and Freight performance areas show generally "good" performance; Bridge and Safety performance areas show generally "poor/below average" or "fair/average" performance
- Pavement Performance: The weighted average of the Pavement Index shows "good" performance for the I-40 West corridor; exceptions include Segments 40W-4 and 40W-13, which show "poor" performance for the Pavement Index; the weighted average of % Area Failure shows "poor" performance for the corridor; all segments except Segments 40W-3 and 40W-7 have Pavement hot spots
- Bridge Performance: The weighted average of the Bridge Index shows "fair" performance along the I-40 West corridor; the Bridge index predominantly shows "fair" performance, with the exception of Segments 40W-1 and 40W-7, which show "poor" and "good" performance, respectively, the weighted average for Lowest Bridge Rating shows "poor" performance for the corridor; all segments except Segments 40W-3, 4, 7, 11, and 13 have Bridge hot spots
- Mobility Performance: The weighted average of the Mobility Index shows "good" performance throughout the I-40 West corridor; the EB Closure Extent, EB Directional TTI, and EB/WB Directional PTI all show "fair" performance; the % Non-SOV Trips shows "poor" performance for the corridor along with many individual segments
- Safety Performance: The weighted average of the Safety Index shows "average" performance for the I-40 West corridor; performance measures for crashes involving motorcycles and non-motorized travelers had insufficient data to generate reliable performance ratings; several segments had insufficient data to generate reliable performance ratings for crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; the weighted averages show "average" performance for the Directional Safety Index and crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; Segments 40W-3 and 40W-10 have Safety hot spots
- Freight Performance: The weighted average of the Freight Index shows "good" performance along the I-40 West corridor; Closure Duration shows "poor" performance for Segments 40W-4 through 40W-14 in the EB direction, including the weighted corridor average, and for Segments 40W-10 through 40W-12 in the WB direction; no Freight hot spots exist along the corridor
- Lowest Performing Segments: Segments 40W-1, 40W-10, and 40W-11 have "poor/below average" performance for many performance measures
- Highest Performing Segments: Segments 40W-7, 40W-9, and 40W-14 have "good/above average" performance for many performance measures

Table ES-2: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			EB	WB								EB	WB	EB	WB	EB	WB	EB	WB		
40W-1[b2]	11	4.10	4.03	4.12	5%	3.66	81.10	5.7%	3	0.28	0.39	0.18	0.18	0.15	0.05	1.23	1.10	1.56	1.28	98%	9.8%
40W-2[b2]	32	4.38	4.29	4.21	2%	5.78	90.49	5.9%	4	0.29	0.40	0.19	0.19	0.16	0.09	1.12	1.09	1.29	1.22	50%	10.7%
40W-3[a1]	12	4.11	4.06	4.04	0%	5.80	95.02	19.1%	5	0.41	0.53	0.27	0.27	0.28	0.12	1.22	1.14	1.72	1.56	92%	19.0%
40W-4[b2]	19	3.20	3.10	3.48	48%	5.59	93.41	24.4%	5	0.19	0.16	0.19	0.19	0.37	0.17	1.16	1.15	1.69	1.54	100%	12.5%
40W-5[b2]	6	3.64	4.15	3.20	33%	5.13	94.85	21.0%	4	0.28	0.38	0.13	0.13	1.40	0.00	1.27	1.20	1.68	1.57	100%	6.2%
40W-6[b2]	18	3.20	3.41	3.22	54%	5.36	87.52	3.4%	4	0.25	0.34	0.13	0.12	1.20	0.12	1.24	1.10	1.64	1.27	100%	6.8%
40W-7[b2]	10	3.94	3.84	3.95	0%	6.72	95.52	0.0%	6	0.27	0.37	0.15	0.15	1.06	0.00	1.13	1.08	1.31	1.22	100%	6.8%
40W-8[b2]	12	4.09	4.02	3.98	8%	5.71	90.38	49.0%	4	0.29	0.40	0.16	0.15	1.07	0.12	1.09	1.14	1.23	1.37	100%	13.8%
40W-9[b2]	23	4.27	3.93	4.24	2%	5.21	87.19	0.0%	4	0.31	0.42	0.15	0.15	0.89	0.05	1.13	1.12	1.39	1.34	100%	10.8%
40W-10[b2]	17	3.64	3.50	3.55	48%	5.37	91.34	40.1%	4	0.31	0.43	0.13	0.13	0.71	0.59	1.31	1.16	1.98	1.65	100%	12.3%
40W-11[b2]	8	3.26	3.54	3.63	31%	5.81	95.07	23.5%	5	0.32	0.44	0.14	0.14	0.55	0.30	1.16	1.12	1.40	1.36	100%	8.1%
40W-12[b2]	16	3.60	3.76	3.94	9%	5.27	80.51	79.7%	5	0.30	0.38	0.14	0.14	0.45	0.25	1.11	1.13	1.28	1.46	98%	8.3%
40W-13[b2]	6	2.85	3.73	3.52	42%	5.50	97.11	0.0%	5	0.34	0.43	0.21	0.21	0.53	0.23	1.11	1.12	1.30	1.33	98%	12.4%
40W-14[a1]	6	3.73	3.87	3.73	28%	5.11	90.05	0.0%	4	0.51	0.67	0.27	0.27	0.53	0.13	1.04	1.14	1.20	1.36	99%	16.1%
Weighted Corridor Average		3.81	3.81	3.84	20%	5.53	91.23	17%	4.35	0.30	0.39	0.17	0.17	0.62	0.16	1.17	1.12	1.48	1.38	91%	10.9%

SCALES

Performance Level	Interstate			All				Urban and Fringe Urban	All	Uninterrupted		All	
Good/Above Average	> 3.75	> 3.75	< 5%	> 6.5	> 80	< 12%	> 6	< 0.71	< 0.22	< 1.15	< 1.3	> 90%	> 17%
Fair/Average	3.20 - 3.75	3.20 - 3.75	5% - 20%	5.0 - 6.5	50 - 80	12% - 40%	5 - 6	0.71 - 0.89	0.22 - 0.62	1.15 - 1.33	1.3 - 1.5	60% - 90%	11% - 17%
Poor/Below Average	< 3.20	< 3.20	> 20%	< 5.0	< 50	> 40%	< 5	> 0.89	> 0.62	> 1.33	> 1.5	< 60%	< 11%

Performance Level	Rural
Good/Above Average	< 0.56
Fair/Average	0.56 - 0.76
Poor/Below Average	> 0.76

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000

[1]Urban Operating Environment
[2]Rural Operating Environment

Table ES-2: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/milepost/year/mile)		Bridge Vertical Clearance (feet)
			EB	WB						EB	WB	EB	WB	EB	WB	
40W-1[b2]	11	1.35	1.34	1.35	70%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.12	1.06	1.33	1.17	23.11	9.82	16.17
40W-2[b2]	32	1.00	1.19	0.81	65%	24%	Insufficient Data	Insufficient Data	0.87	1.05	1.03	1.16	1.13	42.11	22.21	16.14
40W-3[a1]	12	1.26	1.47	1.06	37%	11%	Insufficient Data	Insufficient Data	0.75	1.14	1.04	1.47	1.18	51.27	17.52	16.25
40W-4[b2]	19	1.75	1.46	2.04	32%	24%	Insufficient Data	Insufficient Data	0.71	1.11	1.10	1.48	1.33	154.41	24.21	16.25
40W-5[b2]	6	0.67	0.08	1.26	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.73	1.17	1.10	1.42	1.32	741.13	0.00	No UP
40W-6[b2]	18	1.59	1.36	1.81	45%	18%	Insufficient Data	Insufficient Data	0.78	1.15	1.03	1.42	1.15	686.31	46.59	16.00
40W-7[b2]	10	1.20	1.52	0.88	20%	Insufficient Data	Insufficient Data	Insufficient Data	0.86	1.07	1.03	1.21	1.13	641.44	0.00	16.65
40W-8[b2]	12	0.26	0.27	0.24	23%	15%	Insufficient Data	Insufficient Data	0.87	1.02	1.07	1.11	1.19	637.78	15.95	16.56
40W-9[b2]	23	0.67	0.85	0.49	35%	12%	Insufficient Data	Insufficient Data	0.82	1.06	1.05	1.24	1.18	458.46	13.70	16.00
40W-10[b2]	17	2.09	1.22	2.96	44%	20%	Insufficient Data	Insufficient Data	0.64	1.23	1.09	1.69	1.45	374.77	491.32	16.27
40W-11[b2]	8	0.93	0.92	0.93	75%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.08	1.06	1.26	1.23	202.70	285.30	16.20
40W-12[b2]	16	0.33	0.13	0.54	25%	0%	Insufficient Data	Insufficient Data	0.81	1.05	1.07	1.16	1.29	216.38	247.11	16.17
40W-13[b2]	6	0.55	0.91	0.19	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.84	1.05	1.04	1.19	1.18	217.40	101.72	17.30
40W-14[a1]	6	0.32	0.60	0.04	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.83	1.03	1.10	1.15	1.27	204.27	34.33	16.27
Weighted Corridor Average		1.08	1.02	1.14	43.5%	16.6%	Insufficient Data	Insufficient Data	0.80	1.09	1.06	1.31	1.22	308.92	93.06	16.22

SCALES										
Performance Level	**Urban 4 Lane Freeway**					**Uninterrupted**			**All**	
Good/Above Average	< 0.79	< 49.1%	< 6.8%	< 9.3%	< 4.8%	> 0.77	< 1.15	< 1.3	< 44.18	> 16.5
Fair/Average	0.79 - 1.21	49.1% - 59.4%	6.8% - 10.9%	9.3% - 11.5%	4.8% - 10.3%	0.67 - 0.77	1.15 - 1.33	1.3 - 1.5	44.18 - 124.86	16.0 - 16.5
Poor/Below Average	> 1.21	> 59.4%	> 10.9%	> 11.5%	> 10.3%	< 0.67	> 1.33	> 1.5	> 124.86	< 16.0
Performance Level	**Rural 4 Lane Freeway with Daily Volume < 25,000**									
Good/Above Average	< 0.73	< 42.8%	< 13.2%	< 5%	< 1.7%					
Fair/Average	0.73 - 1.27	42.8% - 52.9%	13.2% - 17.0%	5% - 8.5%	1.7% - 2.5%					
Poor/Below Average	> 1.27	> 52.9%	> 17.0%	> 8.5%	> 2.5%					

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000
[1]Urban Operating Environment
[2]Rural Operating Environment

Notes: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings
"No UP" indicates no underpasses are present in the segment

NEEDS ASSESSMENT

Corridor Description

The I-40 West corridor is and will continue to be a major transportation corridor for intrastate and interstate commerce, intercity travel, and tourism. I-40 is designated by ADOT as a strategic highway corridor, a key commerce corridor, and part of the National Primary Freight Network.

Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to I-40 West performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three "emphasis areas" were identified for the I-40 West corridor: Pavement, Bridge, and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Needs Assessment Process

The performance-based needs assessment evaluates the difference between the baseline performance and the performance objectives for each of the five performance areas used to characterize the health of the corridor: Pavement, Bridge, Mobility, Safety, and Freight. The performance-based needs assessment process is illustrated in **Figure ES-4**.

The needs assessment compares baseline corridor performance with performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown in **Figure ES-5**.

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. A detailed review of available data helps identify contributing factors to the need and if there is a high level of historical investment.

Figure ES-4: Needs Assessment Process

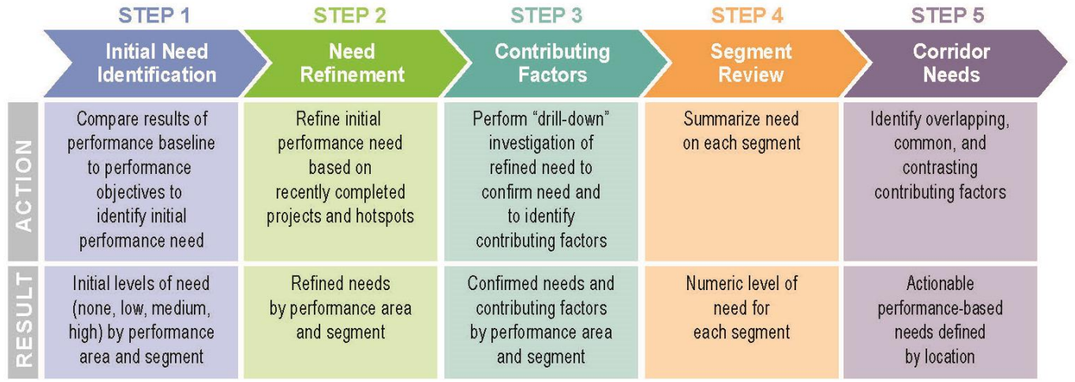


Figure ES-5: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
5.0	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Summary of Needs

Table ES-3 provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Bridge, and Safety for the I-40 West corridor). There are no segments with a High average need, eleven segments with a Medium average need, and three segments with a Low average need. More information on the identified final needs in each performance area is provided below.

Pavement Needs

- Overall Pavement needs are Low or None throughout the corridor except for Segment 40W-11 and Segment 40W-13, which have High levels of need; both segments with High levels of need will be addressed by programmed improvement projects
- Twelve segments contain Pavement hot spots, but all of these except for three segments (40W-1, 40W-2, and 40W-14) have been addressed by recently completed projects, will be addressed by programmed improvement projects, or are segments that have not experienced high levels of historical investment
- Through a field review, a review of previously completed geotechnical reports, and discussions with ADOT District staff, it has been determined that there are likely sub-surface issues at the hot spots in Segment 40W-1 at milepost (MP) 3-4 and in Segment 40W-14 at MP 195-196, and that the limits of the hot spots should be expanded to MP 3-8 in Segment 40W-1 and to MP 191-196 in Segment 40W-14 to address the historical Pavement needs in the area

Bridge Needs

- Overall Bridge needs are High for Segments 40W-1, 5, and 12 and Medium for Segments 40W-8, 9, 13, and 14
- Sixty-six of the 149 bridges on the corridor exhibit needs in the Bridge performance area; approximately 50% of the bridges with needs have programmed improvement projects
- Ten bridges are both hot spots and bridges identified in the historical review; these bridges are in Segments 40W-1, 2, 8, 10, and 14

Mobility Needs

- Overall Mobility needs are Low throughout the corridor; there are no programmed projects to address identified Mobility needs
- Mobility needs are primarily related to an above average frequency of full freeway closures, likely due to weather and incidents, or related to a below average planning time index (PTI), likely due to grades, congestion, incidents, and weather

Safety Needs

- Overall Safety needs are High for Segments 40W-1, 4, 6, and 10 and Medium for Segments 40W-2, 3, 7, and 11; there are no programmed projects that are anticipated to fully address identified Safety needs
- Safety hot spots are in Segment 40W-3 at MP 48-51 EB/WB and in Segment 40W-10 at MP 157-158 WB
- Crashes involving single vehicles travelling at speeds too fast for conditions, overturned vehicles, fixed objects, and/or roadway departures exceed the statewide average crashes for similar operating environments on the majority of the I-40 West corridor
- Truck-involved crashes comprise over 24 percent of total crashes between MP 11-43 in Segment 40W-2; crashes in this segment typically involve distracted or inattentive drivers, road departures, fixed object, and overturning

Freight Needs

- Overall Freight needs are Low throughout the corridor except for Segment 40W-4, which has a Medium need, and Segment 40W-10, which has a High need; there are no programmed projects to address identified Freight needs
- Freight needs are primarily related to an above average duration of full freeway closures, likely due to weather and incidents, or related to a below average truck PTI, likely due to grades, congestion, incidents, and weather
- There are no Freight hot spots on the I-40 West corridor

Overlapping Needs

This section identifies overlapping performance needs on the I-40 West corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- A majority of the segments on the I-40 West corridor shows some level of need in four out of the five performance areas
- Segment 40W-1 and Segment 40W-10 have High levels of need in two performance areas: Safety and Freight
- Segments 40W-4, 11, and 13 have a High level of need in one performance area and a Medium level of need in another performance area

Table ES-3: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)													
	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement[+]	Low	Low	None	None	None	Low	None	Low	Low	None	High	Low	High	Low
Bridge[+]	High	Low	Low	Low	High	Low	None	Medium	Medium	Low	Low	High	Medium	Medium
Mobility	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Safety[+]	High	Medium	High	High	Low	High	Medium	Low	None	High	Medium	None	None	None
Freight	Low	Low	Low	Medium	Low	Low	Low	Low	Low	High	Low	Low	Low	Low
Average Need	**1.92**	**1.23**	**1.23**	**1.38**	**1.23**	**1.46**	**0.77**	**1.23**	**1.00**	**1.54**	**1.69**	**1.23**	**1.46**	**1.00**

Average Need Scale	
None[*]	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

[+] *Identified as an emphasis area for the I-40 West corridor*

[*] *A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study*

STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need as addressing these needs will have the greatest effect on corridor performance. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The I-40 West strategic investment areas (resulting from the elevated needs) are shown in **Figure ES-6**.

Screening Process

In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process.

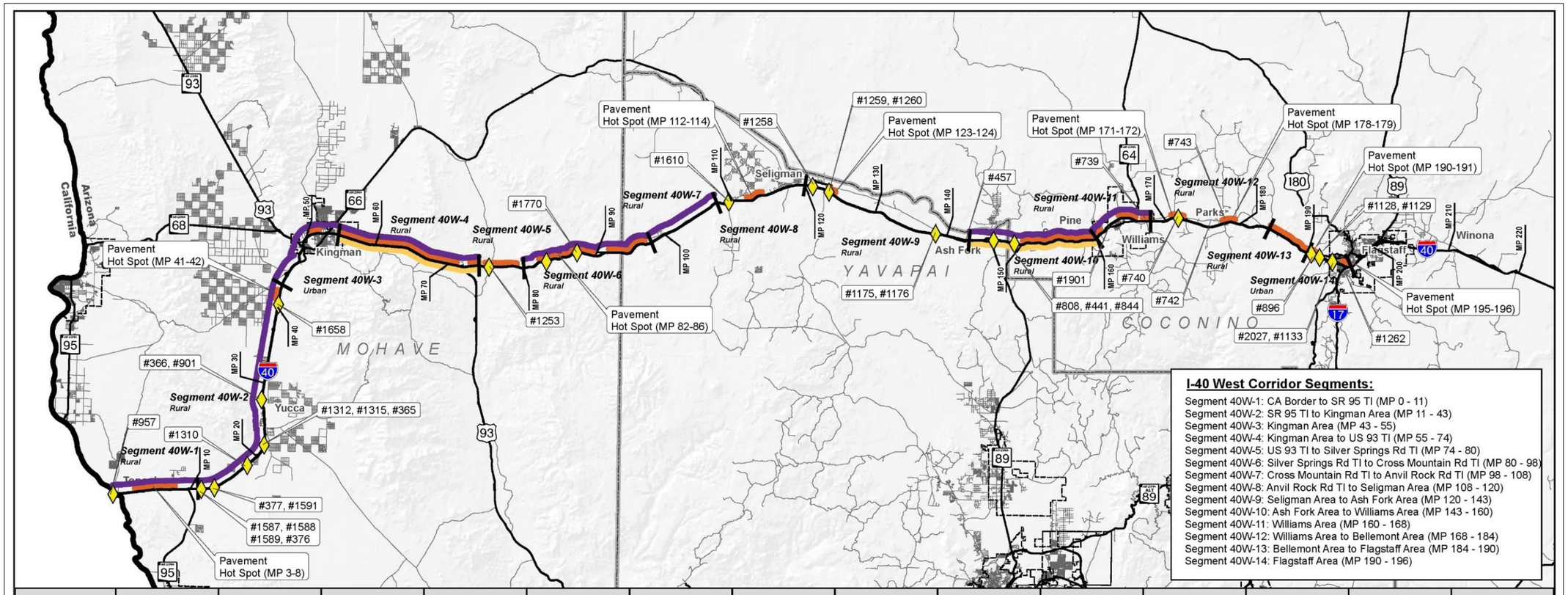
Candidate solutions include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance areas include two options; rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Figure ES-6: Strategic Investment Areas



Performance Area	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement*	Hotspot	Hotspot	-	-	-	Hotspot	-	Hotspot	Hotspot	-	High	Hotspot	High	Hotspot
Bridge*	High	Hotspot	-	-	High	Hotspot	-	Medium	Medium	Hotspot		High	Medium	Medium
Mobility	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Safety*	High	Medium	High	High	-	High	Medium	-	-	High	Medium	-	-	-
Freight	-	-	-	Medium	-	-	-	-	-	High	-	-	-	-

** Identified as emphasis area for I-40 West corridor*

Note: Figure shows strategic investment areas which are segments with Medium and High levels of need and locations of hot spots. A "-" symbol indicates a segment level of need of Low or None, which is not considered strategic."

I-40 West Corridor Profile Study: MP 0 to MP 196
Strategic Investment Areas

N
Miles
0 10 20

Interstate/Highway
Corridor Segment
County Boundary
City Boundary
#1234 ADOT Structure Number

Performance Area Needs
Pavement
Mobility
Safety
Freight
Bridge

Level of Need
Low
Medium
High

SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation is shown in **Figure ES-7** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

All Mobility, Safety, and Freight strategic investment areas that result in multiple independent candidate solutions are advanced directly to the Performance Effectiveness Evaluation.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

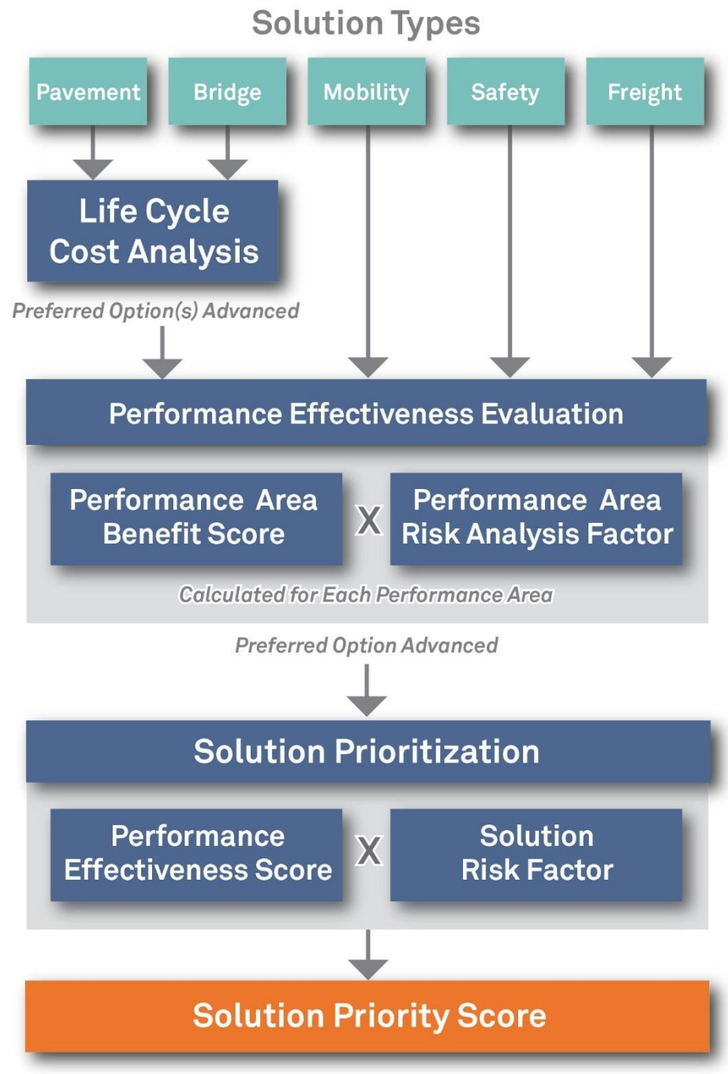
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of the performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure ES-7: Candidate Solution Evaluation Process



SUMMARY OF CORRIDOR RECOMMENDATIONS

Prioritized Candidate Solution Recommendations

Table ES-4 and **Figure ES-8** show the prioritized candidate solutions recommended for the I-40 West corridor. Implementation of these solutions is anticipated to improve performance of the I-40 West corridor in all five performance areas. The highest priority solutions address needs in the Stateline to Kingman area (MP 0-55) and Ash Fork to Williams area (MP 143-160).

Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the I-40 West corridor:

- Expand the limits of the programmed pavement rehabilitation project in FY 2019 at MP 108-123 to also include MP 123-124 to address the Pavement hot spot at MP 123-124
- Expand the limits of the programmed pavement rehabilitation project in FY 2018 at MP 162-179 to also include MP 160-162 to address the Pavement hot spot at MP 160-161
- Expand the scope of the programmed bridge deck rehabilitation project in FY 2019 at the W Flagstaff TI WB Bridge #1129 at MP 192 to also include bridge superstructure rehabilitation to address the low superstructure rating at this bridge
- Conduct an interchange operations study for the I-40/SR 95 interchange near MP 10
- Promote planned construction of I-40/US 93 system interchange near MP 49

Policy and Initiative Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through the CPS process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the I-40 West corridor, but across the entire state highway system where conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects; in pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network

Next Steps

Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process. It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives. Upon completion of all three CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.

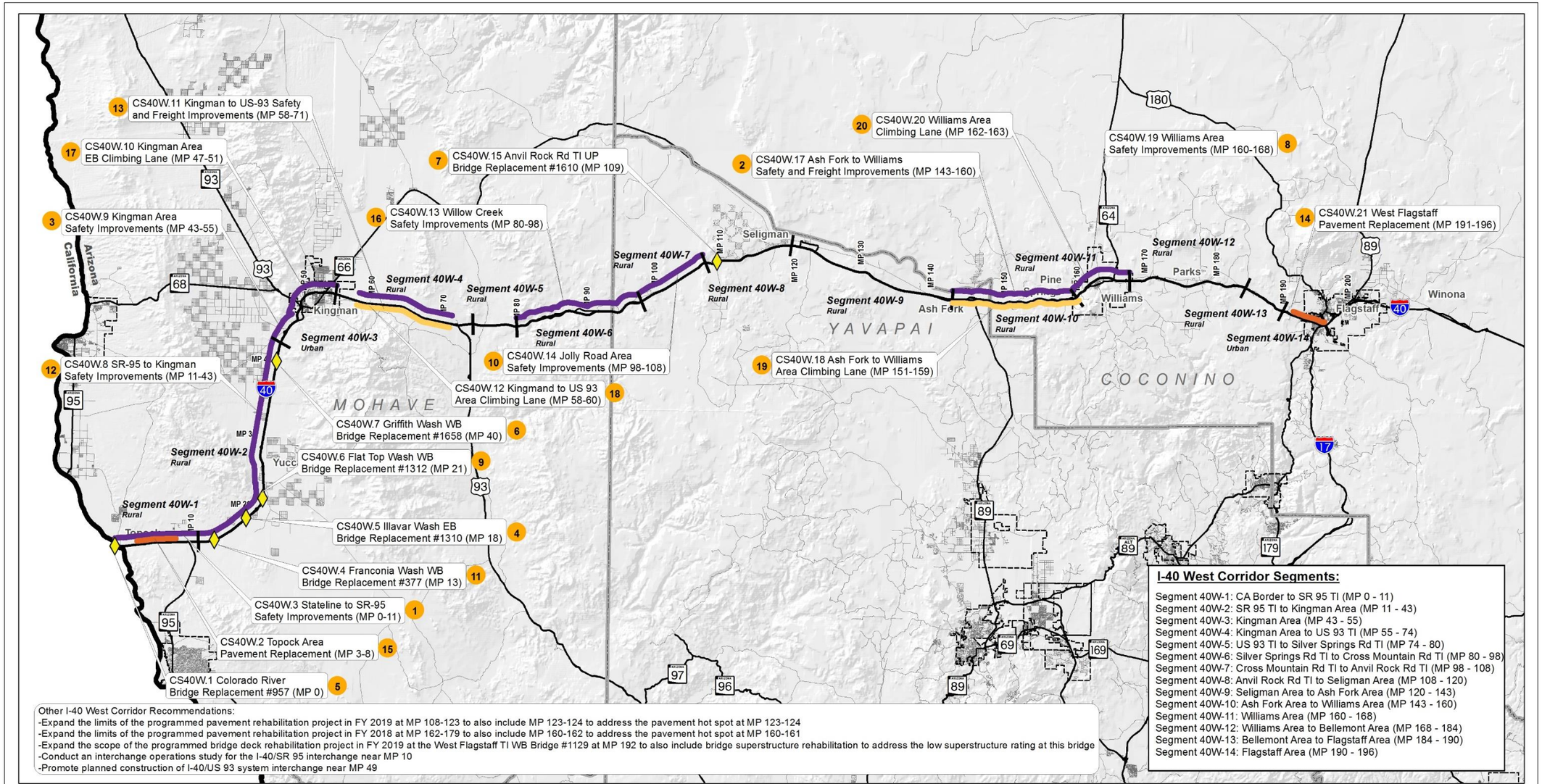
Table ES-4: Prioritized Recommended Solutions

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS40W.3	Stateline to SR 95 Safety Improvements (MP 0-11)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips)	$6.2	M	**64**
2	CS40W.17	Ash Fork to Williams Safety and Freight Improvements (MP 143-160)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement Variable Speed Limits (VSL) at EB/WB MP 151-159 and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at EB MP 144 and with new DMS at WB MP 160	$30.3	M	**58**
3	CS40W.9	Kingman Area Safety Improvements (MP 43-55)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Install median cable barrier at MP 47-51 -Implement VSL at EB/WB MP 47-53 and integrate with existing DMS at EB MP 45 and WB MP 55	$29.0	M	**28**
4	CS40W.5	Illavar Wash EB Bridge #1310 - Replacement (MP 18.30)	-Replace bridge	$1.2	M	**24**
5	CS40W.1	Colorado River Bridge #957 (MP 0)	-Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement; Cost reflects ADOT's anticipated share of costs	$55.0	M	**19**
6	CS40W.7	Griffith Wash WB Bridge #1658 - Replacement (MP 40.42)	-Replace bridge	$2.0	M	**19**
7	CS40W.15	Anvil Rock Rd TI UP Bridge # 1610 - Replacement (MP 108.65)	-Replace bridge	$2.8	M	**18**
8	CS40W.19	Williams Area Safety Improvements (MP 160-168)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 161-163 and integrate with existing RWIS at MP 159 and existing DMS at WB MP 168 and with new DMS at EB MP 160	$12.3	M	**18**
9	CS40W.6	Flat Top Wash WB Bridge #1312 - Replacement (MP 21.01)	-Replace bridge	$2.0	M	**17**
10	CS40W.14	Jolly Road Area Safety Improvements (MP 98-108)	-Rehabilitate shoulder (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 101-104 and integrate with new RWIS at MP 103 and new DMS at EB MP 100 and WB MP 105	$14.5	M	**17**
11	CS40W.4	Franconia Wash WB Bridge #377 - Replacement (MP 13.61)	-Replace bridge	$2.3	M	**16**
12	CS40W.8	SR 95 to Kingman Safety Improvements (MP 11-43)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Provide signs for driver information (advance notice of rest area)	$18.0	M	**8**
13	CS40W.11	Kingman to US 93 Safety and Freight Improvements (MP 58-71)	-Implement VSL at EB/WB MP 58-71 and integrate with existing DMS at EB MP 69 and with new DMS at EB MP 55 and WB MP 72	$47.7	M	**7**
14	CS40W.21	West Flagstaff Pavement Improvements - Replacement (MP 191-196)	-Replace pavement	$43.2	M	**6**

Table ES-4: Prioritized Recommended Solutions (continued)

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
15	CS40W.2	Topock Area Pavement Improvements - Replacement (MP 3-8)	-Replace pavement	$35.9	M	**4**
16	CS40W.13	Willow Creek Safety Improvements (MP 80-98)	-Construct EB climbing lane at MP 80-83 and MP 93-97 -Widen Echeverria OP EB bridge #1675, MP 94.45 -Widen Cross Mountain TI OP EB bridge #1677, MP 96.02 -Implement VSL at EB MP 80-83, EB MP 88-90, and EB MP 93-97 and integrate with existing RWIS at MP 91 and new DMS at EB MP 79 and WB MP 98	$51.2	M	**4**
17	CS40W.10	Kingman Area Climbing Lane (MP 47-51)	-Construct EB climbing lane MP 47-51 -Widen W Kingman TI OP EB bridge #1835, MP 48.84 -Widen Clack Canyon Wash EB bridge #1837, MP 49.70 -Widen White Cliff Road OP EB bridge #1839, MP 50.09	$25.6	M	**3**
18	CS40W.12	Kingman to US 93 Area Climbing Lane (MP 58-60)	-Construct EB climbing lane at MP 58-60	$7.5	M	**2**
19	CS40W.18	Ash Fork to Williams Area Climbing Lane (MP 151-159)	-Construct EB climbing lane at MP 151-152 and MP 156-159 -Widen Devil Dog TI OP EB bridge #1178, MP 157.71	$22.8	M	**1**
20	CS40W.20	Williams Area Climbing Lane (MP 162-163)	-Construct WB climbing lane at MP 162-163 -Widen SFRR and Cata Lake OP WB bridge #1902, MP 162.38	$5.6	M	**1**

Figure ES-8: Prioritized Recommended Solutions



Final Report

Final Report

1.0 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study (CPS) of the western portion of Interstate 40 (I-40) between the California State Line and Interstate 17 (I-17). The study examines key performance measures relative to the I-40 West corridor, and the results of this performance evaluation are used to identify potential strategic improvements. The intent of the corridor profile program, and of ADOT's Planning-to-Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network.

ADOT is conducting eleven CPS within three separate groupings.

The first three studies (Round 1) began in Spring 2014, and encompass:

- I-17: SR 101L to I-40
- I-19: Nogales to I-10
- I-40: California State Line to I-17

The second round (Round 2) of studies, initiated in Spring 2015, includes:

- I-8: California State Line to I-10
- I-40: I-17 to the New Mexico State Line
- SR 95: I-8 to I-40

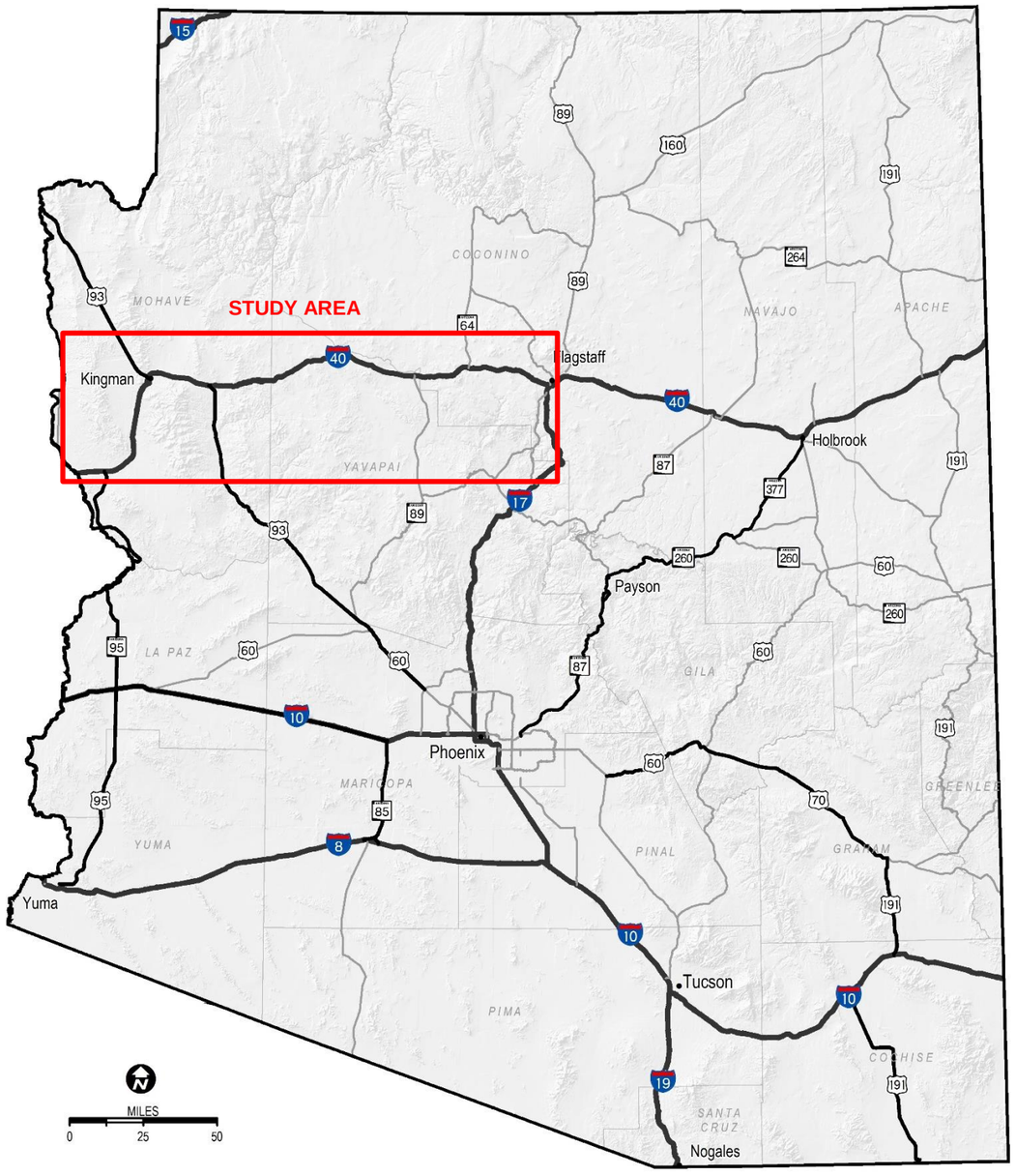
The third round (Round 3) of studies, initiated in Fall 2015, includes:

- I-10: California State Line to SR 85 and SR 85: I-10 to I-8
- I-10: SR 202L to the New Mexico State Line
- SR 87/SR 260/SR 377: SR 202L to I-40
- US 60/US 70: SR 79 to US 191 and US 191: US 70 to SR 80
- US 93/US 60: Nevada State Line to SR 303L

The studies under this program assess the overall health, or performance, of the state's strategic highways. The CPS will identify candidate solutions for consideration in the Multimodal Planning Division's (MPD) P2P project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

The I-40 West corridor, depicted in **Figure 1,** is one of the strategic statewide corridors identified and the subject of this Round 1 CPS.

Figure 1: Corridor Study Area



1.1 Corridor Study Purpose

The purpose of the CPS is to measure corridor performance to inform the development of strategic solutions that are cost-effective and account for potential risks. This purpose can be accomplished by following the process described below:

- Inventory past improvement recommendations
- Define corridor goals and objectives
- Assess existing performance based on quantifiable performance measures
- Propose various solutions to improve corridor performance
- Identify specific solutions that can provide quantifiable benefits relative to the performance measures
- Prioritize solutions for future implementation, accounting for performance effectiveness and risk analysis findings

1.2 Study Goals and Objectives

The objective of this study is to identify a recommended set of prioritized potential solutions for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The I-40 West CPS defines solutions and improvements for the corridor that are evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing performance. Corridor benefits can be categorized by the following three investment types:

- Preservation: Activities that protect transportation infrastructure by sustaining asset condition or extending asset service life
- Modernization: Highway improvements that upgrade efficiency, functionality, and safety without adding capacity
- Expansion: Improvements that add transportation capacity through the addition of new facilities and/or services

This study identifies potential actions to improve the performance of the I-40 West corridor. Proposed actions are compared based on their likelihood of achieving desired performance levels, life-cycle costs, cost-effectiveness, and risk analysis to produce a prioritized list of solutions that help achieve corridor goals.

The following goals are identified as the desired outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

1.3 Corridor Overview and Location

The I-40 West corridor is a 196-mile freeway corridor located in western Arizona that serves interstate, regional, and local traffic and commerce demands between the ports of California and destinations east. The corridor study limits extend from milepost (MP) 0 at the California state line to MP 196 in Flagstaff, east of the I-40/I-17 freeway interchange. I-40 is designated by ADOT as a strategic highway corridor, a key commerce corridor, and part of the National Primary Freight Network. Safe and reliable movement of people, vehicles, and goods, and the maintenance of corridor infrastructure, including pavement and bridges, are high priorities for I-40. Within the urbanized areas of Flagstaff and Kingman, the I-40 West corridor serves as a route for daily commuters and intrastate/interstate travel in and through the urbanized areas.

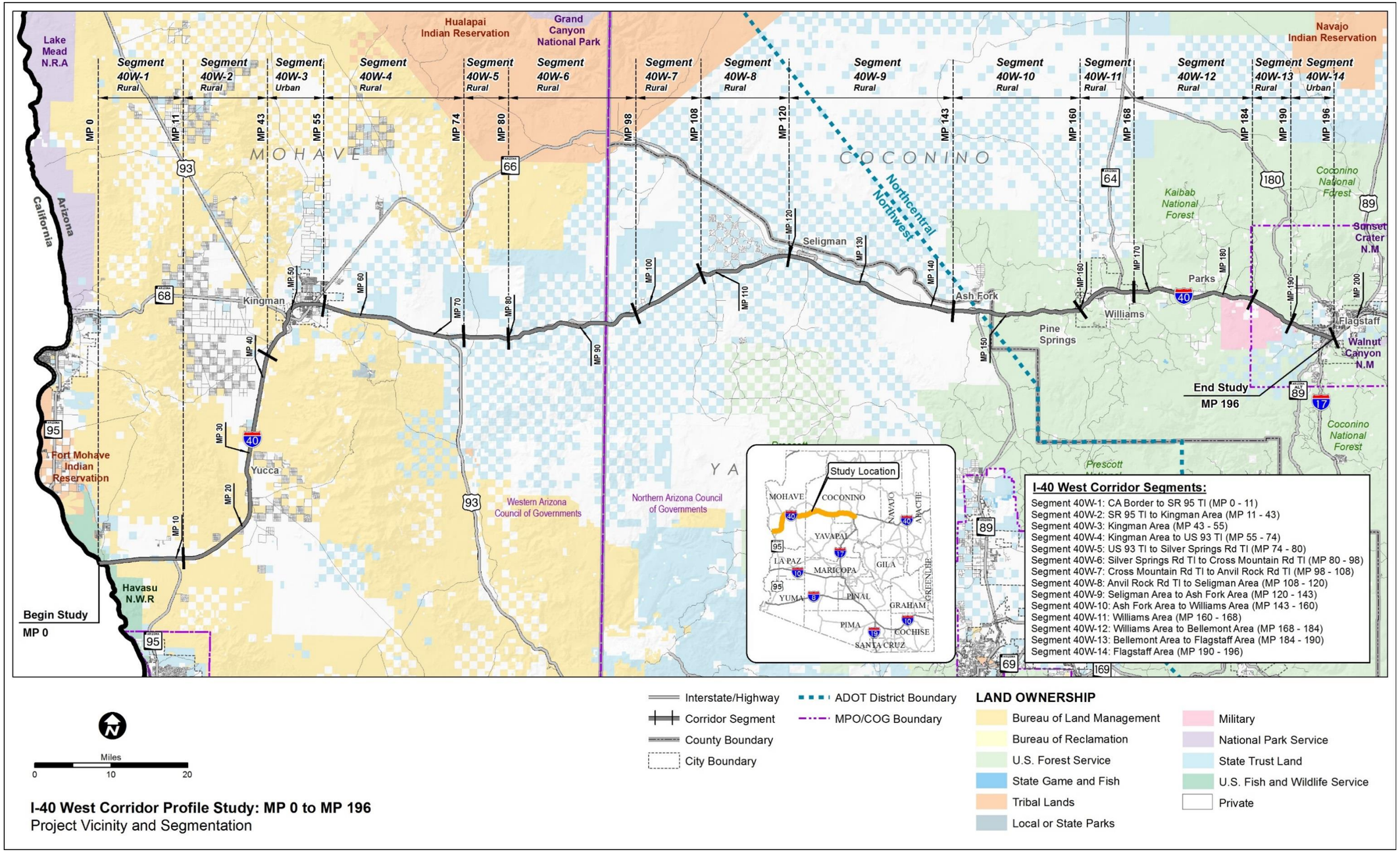
1.4 Corridor Segments

The I-40 West corridor is divided into 14 planning segments to allow for an appropriate level of detailed needs analysis, performance evaluation, and comparison between different segments of the corridor. The corridor is segmented at logical breaks where the context changes due to differences in characteristics such as terrain, daily traffic volumes, or roadway typical sections. Corridor segments are described in **Table 1** and shown in **Figure 2**.

Table 1: I-40 West Corridor Segments

Segment #	Route	Begin	End	Approximate Begin Milepost	Approximate End Milepost	Approximate Length (miles)	Typical Through Lanes (EB, WB)	2014/2035 Average Annual Daily Traffic Volume (vpd)	Character Description
40W-1	I-40	California State Line	SR 95 Junction	0	11	11	(2,2)	13,000/28,500	Rural 4 lane freeway, 3 traffic interchanges (TIs), one port-of-entry (POE), Havasu National Wildlife Refuge, State Trust land, Bureau of Land Management (BLM) land, private land, community of Topock, junction with State Route (SR) 95 (which connects to Lake Havasu City)
40W-2	I-40	SR 95 Junction	Shinarump Drive TI	11	43	32	(2,2)	13,500/29,200	Rural 4 lane freeway, 6 TIs, BLM and private land, community of Yucca, includes Chrysler Arizona Proving Ground
40W-3	I-40	Shinarump Drive TI	SR 66 Junction	43	55	12	(2,2)	21,000/39,500	Urban 4 lane freeway, 4 TIs, BLM and private land, city of Kingman, junction with US 93 (which connects to Las Vegas), junction with SR 66 (which connects to Peach Springs)
40W-4	I-40	SR 66 Junction	Junction US 93	55	74	19	(2,2)	17,200/11,900	Rural 4 lane freeway, 3 TIs, State Trust land, BLM and private land, junction with US 93 (which connects to Wickenburg), shared route with US 93, planned future I-11 route
40W-5	I-40	Junction US 93	Silver Springs Road TI	74	80	6	(2,2)	13,000/28,700	Rural 4 lane freeway, 1 TI, State Trust and private land, Silver Springs Road
40W-6	I-40	Silver Springs Road TI	Fort Rock Road TI	80	98	18	(2,2)	11,900/26,200	Rural 4 lane freeway, 3 TIs, State Trust and private land, Willow Creek, separate carriageways
40W-7	I-40	Fort Rock Road TI	Anvil Rock Road TI	98	108	10	(2,2)	12,900/28,400	Rural 4 lane freeway, 1 TI, State Trust and private land, Jolly Road
40W-8	I-40	Anvil Rock Road TI	Route 66 Junction	108	120	12	(2,2)	13,700/30,200	Rural 4 lane freeway, 1 TI, State Trust and private land, Anvil Rock Road
40W-9	I-40	Route 66 Junction	SR 89 Junction	120	143	23	(2,2)	14,200/31,200	Rural 4 lane freeway, 2 TIs, State Trust and private land, community of Seligman, junction with Route 66 (which connects to Peach Springs)
40W-10	I-40	SR 89 Junction	Country Club Drive TI	143	160	17	(2,2)	14,400/32,400	Rural 4 lane freeway, 7 TIs, private and National Forest land, communities of Ash Fork and Pine Springs, junction with SR 89 (which connects to Chino Valley)
40W-11	I-40	Country Club Drive TI	Garland Prairie Road TI	160	168	8	(2,2)	15,800/33,800	Rural 4 lane freeway, high elevation, 4 TIs, private and National Forest land, community of Williams, junction with SR 64 (which connects to the Grand Canyon)
40W-12	I-40	Garland Prairie Road TI	Transwestern Road TI	168	184	16	(2,2)	16,100/29,300	Rural 4 lane freeway, high elevation, 2 TIs, private and National Forest land, community of Parks, Navajo Army Depot
40W-13	I-40	Transwestern Road TI	A-1 Mountain Road TI	184	190	6	(2,2)	18,600/32,700	Rural 4 lane freeway, high elevation, 1 TI, National Forest land, community of Bellemont, Navajo Army Depot
40W-14	I-40	A-1 Mountain Road TI	Junction I-17	190	196	6	(2,2)	27,400/51,600	Urban 4 lane freeway, high elevation, 4 TIs, State Trust land, National Forest and private land, city of Flagstaff, junction with I-17 (which connects to Camp Verde and Flagstaff)

Figure 2: Corridor Location and Segments



I-40 West Corridor Profile Study: MP 0 to MP 196
Project Vicinity and Segmentation

1.5 Corridor Characteristics

The I-40 West corridor is an important travel corridor in the northern part of the state. The corridor functions as a route for freight, recreational, tourist, and regional traffic and provides critical connections between the communities it serves and the rest of the regional and interstate network.

National Context

With a length of approximately 2,560 miles, I-40 is the third-longest Interstate Highway in the United States. Its western terminus is I-15 in Barstow, California and its eastern terminus is US Route 117 in Wilmington, North Carolina. I-40 intersects with eight of the nation's 10 north-south interstates and provides access to eight states and many major U.S. cities including Raleigh, North Carolina; Nashville, Tennessee; Memphis, Tennessee; Oklahoma City, Oklahoma; and Albuquerque, New Mexico. Between Oklahoma City and Barstow, I-40 parallels or overlays the historic US Route 66. Segments of I-40 parallel the Burlington Northern Santa Fe (BNSF) Southern Transcon (transcontinental) mainline and Amtrak railroads

Regional Connectivity

I-40 is Arizona's northernmost continuous east/west transportation corridor, stretching beyond Arizona's border with California and New Mexico. The connectivity that I-40 provides attracts commercial/truck, inter-city, commuter, recreational, and out-of-state through traffic. Within the corridor study limits, I-40 offers connections to State and U.S. highways including State Route (SR) 95, US 93, SR 66, SR 89, SR 64, and I-17. These highways provide access to tourist attractions, Native American reservations, and other Arizona cities. Arizona communities that are linked by the I-40 West corridor include Topock, Yucca, Seligman, Ash Fork, Pine Springs, Williams, Parks, Bellemont, and the two largest cities along the I-40 West corridor, Kingman and Flagstaff.

Commercial Truck Traffic

I-40 is experiencing increasing freight flows from both domestic and international sources. The corridor's location facilitates commercial freight flow between major Pacific coast ports and mid-western U.S. regions. According to the AADT & KDT Report for Year 2013, average daily truck volumes on I-40 range from approximately 1,500 to 9,500 trucks per day, which corresponds to 15%-45% of the total traffic stream. The I-40 West corridor segments within the vicinity of Kingman and Flagstaff experience particularly high commercial/truck activity. Kingman and Flagstaff are identified as key regional trade, service, and distribution centers of northern Arizona with their strategic location relative to Los Angeles, Las Vegas, and Phoenix.

The Topock Port-of-Entry (POE) facility is located on I-40 approximately four miles east of the California border. The facility performs inspections and other duties to enforce state and federal laws for commercial vehicles. Per the 2013 Arizona POE Study, the Topock POE experienced an annual inbound traffic volume of 557,351 vehicles in 2011.

Commuter Traffic

A majority of the commuter traffic along the I-40 West corridor occurs within the urbanized areas of Kingman and Flagstaff. These areas are economic centers along what is considered mostly a rural interstate. According to 2014 traffic volume data maintained by ADOT, traffic volumes range from approximately 12,000 vehicles per day in rural areas to 33,000 vehicles per day near Kingman.

Per the 2011 American Community Survey data from the U.S. Census Bureau, 78% of the workforce in northern Arizona relies on a private vehicle to get to work. The average commute travel time for commuters from small rural communities such as Parks and Williams is 20-33 minutes. The smaller communities along I-40 have a high percentage of workers commuting to larger cities, such as Flagstaff or Kingman.

Recreation and Tourism

I-40 provides access to many northern Arizona attractions such as national and state parks, environmental preserves, and other recreational activities. Tourist attractions near Flagstaff include Arizona Snowbowl and Sunset Crater Volcano National Monument. The Grand Canyon National Park, approximately 60 miles north of I-40, is accessible from I-40 via U.S.180 or SR 64 and is one of the most visited attractions in Arizona, with nearly 5 million visitors each year. Other recreational destinations accessible from I-40 include Sedona (via SR 89), Lake Havasu (via SR 95), Las Vegas (via US 93), and Phoenix (via US 93 and I-17).

Multimodal Uses

Freight Rail

The BNSF Southern Transcon mainline runs parallel to I-40 across Arizona. BNSF transports approximately 150 million gross tons annually. It is estimated that the BNSF mainline carries approximately 120 trains a day, with 90% of its rail traffic classified as intermodal.

Passenger Rail

Along the corridor, the existence of the BNSF mainline rail infrastructure provides intercity rail travel opportunities via Amtrak. Amtrak stations exist in both Flagstaff and Williams and provide access to destinations including Los Angeles and Chicago. The Grand Canyon Railway has a depot in Williams and provides train service for tourists to the Grand Canyon.

Bicycles/Pedestrians

Opportunities for bicycle and pedestrian travel are limited on I-40. Pedestrians are prohibited on the I-40 mainline. Bicycle traffic is permitted on the I-40 mainline shoulder. Alternate mode transportation facilities are being planned and implemented in some communities along the I-40 West corridor in response to regional and small area transportation plans.

Bus/Transit

Greyhound has transit stations in Flagstaff and Williams and offers daily intercity bus service to various major destinations, including Las Vegas, Albuquerque, and Phoenix. Private transportation

services exist on a limited basis. These services do not serve the typical day-to-day commuter population but are primarily for recreational activities with the potential for business-related and special needs trips. The private transportation companies provide daily shuttle services mainly between Flagstaff and Williams with other nearby destinations. Other shuttle services also provide door-to-door transportation services from the Flagstaff airport to destinations reaching Laughlin and Las Vegas in Nevada. Typically, these services provide three daily shuttle trips during the peak season.

Aviation

A number of airports are located within the vicinity of the I-40 West corridor. The larger airports include the Flagstaff-Pulliam Airport (south of Flagstaff), Williams Municipal Airport, and Kingman Airport. The Flagstaff-Pulliam Airport is owned and operated by the City of Flagstaff and offers commercial and general aviation services. The Williams Municipal and Kingman airports provide general aviation services

Land Ownership, Land Uses and Jurisdictions

As shown previously in **Figure 2**, the corridor traverses multiple jurisdictions and land holdings located in three Arizona counties: Mohave, Yavapai, and Coconino. A majority of the land on the western end of I-40 (west of Kingman) is owned by the Bureau of Land Management with a small area of land ownership by the U.S. Fish and Wildlife Service along the Colorado River. The central section of I-40 between Kingman and Ash Fork is principally Arizona State Trust Land with pockets of private land. The eastern end of I-40 (west of Flagstaff) is principally owned by the U.S. Forest Service or U.S. Military or is State Trust Land.

Population Centers

Population centers of various sizes exist along the I-40 West corridor. **Table 2** provides a summary of current (2015) and future (2040) populations for the three counties and some communities along the I-40 West corridor. In comparison to 2015 population estimates, Kingman and Mohave County as a whole have recorded the highest growth in population with increases of approximately 52%.

Strong growth in population is expected to continue in Flagstaff and Kingman. According to the Arizona State Demographer's Office, the Flagstaff population is forecasted to reach 87,735 in 2040, which represents 27% growth compared to the 2015 population, while the Kingman population is forecasted to reach 45,042 in 2040, which represents nearly 52% growth compared to the 2015 population.

Table 2: Current and Future Population

Community	2010 Population	2015 Population	2040 Population	% Change 2010-2040	Total Growth 2010-2040
Mohave County	200,186	212,805	322,808	61%	122,622
Kingman	28,068	29,693	45,042	60%	16,974
Yavapai County	211,033	220,774	321,924	53%	110,891
Coconino County	134,421	137,903	161,346	20%	26,925
Flagstaff	65,870	69,119	87,735	33%	21,865
Williams	3,023	3,020	3,152	4%	129

Source: U.S. Census, Arizona Department of Administration – Employment and Population Statistics

Major Traffic Generators

The cities of Flagstaff and Kingman are major traffic generators in the region. Both are regional centers for commercial traffic with connectivity to other U.S. and State highways, which results in high truck traffic volumes. Flagstaff and Williams act as a gateway to the Grand Canyon while Kingman acts as a gateway to Las Vegas. Other Flagstaff area traffic generators include Northern Arizona University (NAU), Arizona Snowbowl, an airport, medical facilities, and retail shopping areas. Other Kingman area traffic generators include an airport, medical facilities, and retail shopping areas.

Tribes

There are no tribes directly adjacent to the I-40 West corridor. The corridor serves as a regional travel corridor for the nearby Fort Mojave, Hualapai, and Havasupai tribes.

Wildlife Linkages

The Arizona State Wildlife Action Plan (SWAP) provides a 10-year vision for the entire state, identifying wildlife and habitats in need of conservation, insight regarding the stressors to those resources, and actions that can be taken to alleviate those stressors. Using the Habimap Tool that creates an interactive database of information included in the SWAP, the following were identified in relation to the I-40 West corridor:

- Arizona Game and Fish Department (AGFD) Wildlife waters – none
- Arizona Important Bird Areas – Havasu National Wildlife Refuge (California State line to approximately one mile to the east)
- Allotments/Pastures (grazing) – State Land Department (from I-40/SR 95 junction to approximately Ash Fork area) and U.S. Forest Service (lays directly adjacent the corridor from approximately Ash Fork area to Flagstaff)
- Riparian – a few adjacent areas near the corridor just east of Williams
- AGFD Parcels – none
- State Land Trust lands are present at the following locations: near Junction I-40 and SR 95, east of Kingman, spotted through corridor starting near Junction I-40 and US 93 to

approximately Ash Fork, near Junction I-40 and I-17 in Flagstaff; also immediately adjacent areas throughout the corridor

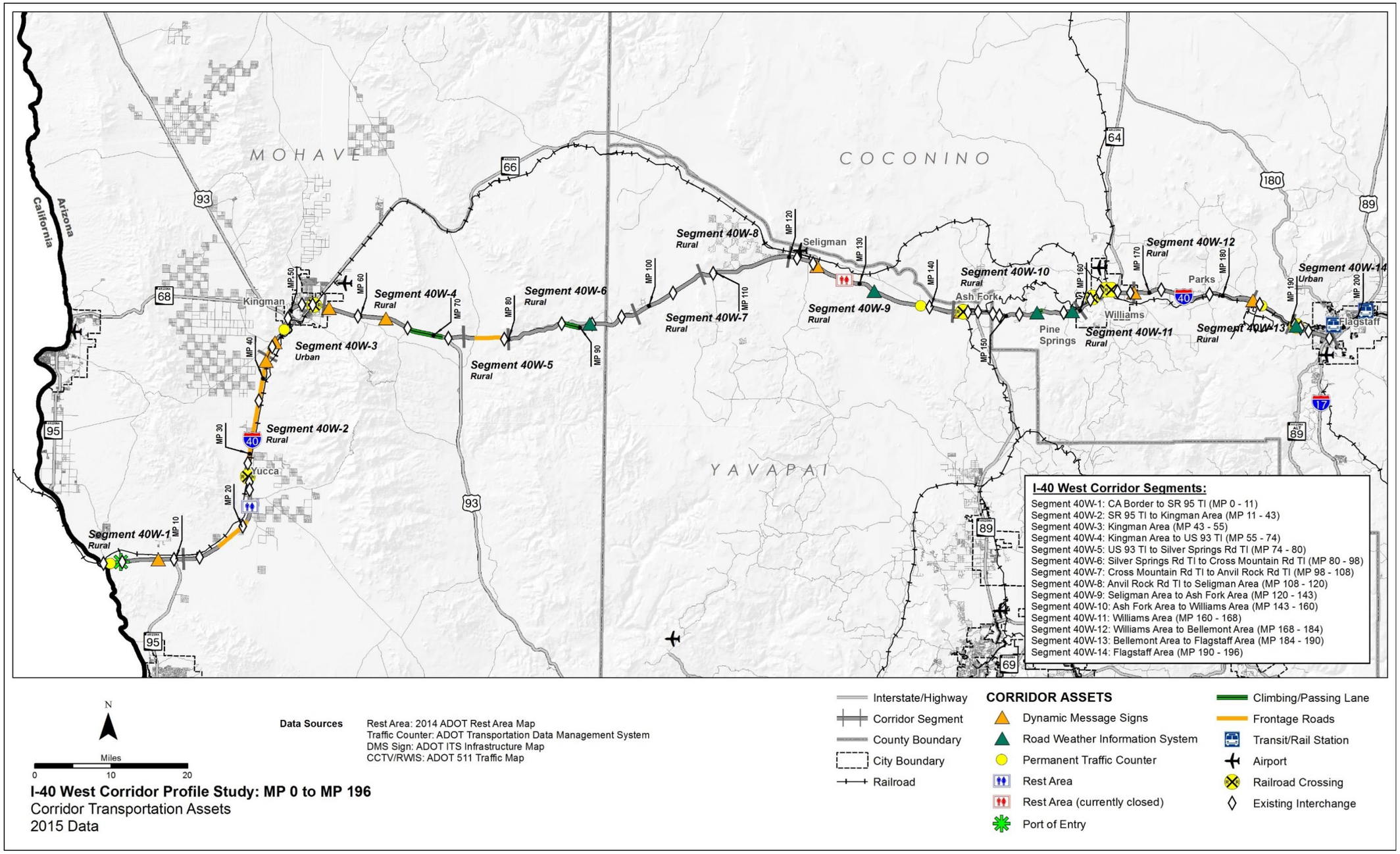
- Arizona Wildlife Linkages – Missing linkages noted: east and west of Junction I-40 and US 93 (approximately MP 63-64, MP 65-66, MP 67-72, MP 87-89, and MP 91-93); potential linkages noted: MP 12-13 near Franconia Road, MP 30-32, MP 47 near Kingman, MP 87, MP 106-146 near Ash Fork, and MP 167-196
- Species and Habitat Conservation Guide (SHCG) – indicates several medium to high value areas of sensitive habitats throughout the eastern part of the corridor, specifically from Ash Fork to Flagstaff
- Species of Economic and Recreational Importance (SERI) – model indicates areas of medium to high importance throughout the eastern end of the corridor, specifically from Williams to Flagstaff
- Species of Greatest Conservation Need (SGCN) – identifies several areas of medium to high value sensitive habitats throughout the eastern part of the corridor, from approximately Junction I-40 and US 93 to Flagstaff

Corridor Assets

Corridor transportation assets are summarized in **Figure 3**. Items of interest include the following:

- Traffic interchanges – 42
- Frontage roads – EB 13 miles; WB 20 miles
- Port of Entry – 1
  - Topock, MP 3.8
- Rest areas – 2
  - Haviland Rest Area, MP 23
  - Parks Rest Area, MP 182 (currently closed)
- Permanent traffic counters – MP 1.44, MP 47.13, MP 138.62, MP 185.55
- Road weather information systems – EB/WB MP 91.38, EB MP 132.25, WB MP 154.19, EB/WB MP 158.94, EB MP 190.78
- Dynamic message signs – EB MP 7.7, EB/WB MP 42.2, EB MP 45, WB MP 55.7, EB MP 69.3, WB 123.9, EB MP 144.0, WB MP 148.1, WB MP 168.0, EB MP 184.5

Figure 3: Corridor Assets



1.6 Corridor Stakeholders and Input Process

A Technical Advisory Committee (TAC) was created that was comprised of representatives from key stakeholders. TAC meetings were held at key milestones to present results and obtain feedback. In addition, several meetings were conducted with key stakeholders between December 2014 and December 2015 to present the results and obtain feedback.

Key stakeholders identified for this study included:

- ADOT Northcentral District
- ADOT Northwest District
- ADOT Technical Groups
- NACOG
- WACOG
- FMPO
- AGFD
- ASLD
- Federal Highway Administration (FHWA)

Several Working Papers were developed during the course of the CPS. The Working Papers were provided to the TAC for review and comment.

1.7 Prior Studies and Recommendations

This study identified recommendations from previous studies, plans, and preliminary design documents. Studies, plans, and programs pertinent to the I-40 West corridor were reviewed to understand the full context of future planning and design efforts within and around the study area. These studies are organized below into four categories: Framework and Statewide Studies, Regional Planning Studies, Planning Assistance for Rural Areas (PARAs) and Small Area Transportation Studies (SATS), and Design Concept Reports (DCRs) and Project Assessments (PAs).

Framework and Statewide Studies

- ADOT 2017-2021 Five-Year Transportation Facilities and Construction Program
- ADOT Statewide Bicycle and Pedestrian Plan Update
- ADOT Climbing and Passing Lane Prioritization Study
- Arizona Key Commerce Corridors
- Arizona Multimodal Freight Analysis Study
- Arizona Ports of Entry Study
- Arizona Roadway Departure Safety Implementation Plan
- Arizona State Rail Plan
- Arizona Statewide Dynamic Message Sign (DMS) Master Plan
- Arizona Statewide Rail Framework Study
- Arizona Statewide Travel Demand Model (AZTDM)
- Arizona Wildlife Action Plan/Arizona Wildlife Linkages Assessment
- Arizona Transparency Report
- Building a Quality Arizona (BQAZ)
- Freight Analysis Framework
- Freight Performance Measures Web Based Tool (FPMWeb)
- National Cooperative Freight Research Program (NCFRP) Report 10: Performance Measures for Freight Transportation
- National Performance Management Research Data Set
- Surface Transportation Board (STB) Carload Waybill Sample
- Transamerica Transportation Corridor Feasibility Study
- Travel Time in Freight Significant Corridors
- What Moves You Arizona? LRTP 2010-2035

Regional Planning Studies

- Flagstaff Pathways 2030 Regional Transportation Plan
- NACOG Regional Transportation Coordination Plan
- WACOG Regional Transportation Three Year Coordination Plan Update, 2014-2015
- A Coordinated Transit Plan for Economic Collaborative of Northern Arizona (ECoNA) in Northern Arizona
- Southern California Association of Governments (SCAG) Goods Movement Truck County Study
- Statewide Transportation Planning Framework, Northern Arizona Regional Framework Study, Working Paper 3 – Scenarios and Evaluation Development
- Statewide Transportation Planning Framework, Western Arizona Regional Framework Study, Working Paper 3 – Scenarios and Evaluation Development
- Strategic Plan for Early Deployment of ITS on I-40
- I-40 Traveler and Tourist Information System (TTIS) Tourist Intercept Survey
- I-40 TTIS Route Diversion Study
- I-40 TTIS Focus Groups and Personal Interviews
- I-40 Multimodal Corridor Profile Study
- Assessment of Out of State Heavy Duty Truck Activity Trends in California
- Arizona's Wildlife Linkages Assessment Document
- Arizona Missing Linkages: Hualapai – Cerbat Linkage Design
- Arizona Missing Linkages: Hualapai – Peacock Linkage Design
- Wildlife Accident Reduction Study and Monitoring: Arizona State Route 64
- Research Report on Elk Movements Associated with Interstate 40 (Williams to Winona)

Planning Assistance for Rural Areas and Small Area Transportation Studies

- Kingman Area Transportation Study Update
- Kingman Stockton Hill Road Corridor Study
- Bellemont Access Management & Multi-Modal Transportation Study
- Flagstaff Regional Five-Year and Long-Range Transit Plan

Design Concept Reports and Project Assessments

- Initial Design Concept Report, I-40, Bellemont Road to Winona
- I-40/US 93 West Kingman Traffic Interchange Feasibility Study
- I-40/US 93 West Kingman Traffic Interchange Final Design Concept Report
- Final Design Concept Report, I-40, Kingman Crossing Traffic Interchange
- Categorical Exclusion, I-40, Kingman Crossing Traffic Interchange
- Final Design Concept Report, I-40, Rattlesnake Wash Traffic Interchange
- Categorical Exclusion, I-40, Rattlesnake Wash Traffic Interchange
- Topock Port of Entry Initial Project Assessment

Summary of Prior Recommendations

Various studies and plans, including several DCRs, have recommended improvements to the I-40 West corridor as shown in **Table 3** and **Figure 4**. Many of these recommendations have already been implemented or programmed for completion.

Table 3: Corridor Recommendations from Previous Studies

Map Key Ref. #.	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
1	0	196	196	Widen I-40 to 6 lanes within the study area			√	N/A	N/A	N	BQAZ, 2010 Statewide Transportation Planning Framework Final Report
2	3	3	N/A	New rest area			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
3	10	10	N/A	I-40/US 95 system interchange			√	N/A	N/A	N	BQAZ, 2010 Statewide Transportation Planning Framework Final Report
4	10	20	10	New traffic interchange			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
5	11	19	8	Bridge deck rehabilitation - Boulder/Franconia/Illavar Wash Bridge EB structure #1587,1589, 1591 & 1310	√			FY 2016	H863401C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
6	22.7	22.7	N/A	I-40 Haviland Rest Area Pavement preservation Design structural rehabilitation Structural rehabilitation	√	 √ √		FY 2016 FY 2017 FY 2018	H876401C H826301D H826301C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
7	37.03	37.13	N/A	Reconstruct Griffith TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
8	44.31	44.31	N/A	Reconstruct McConnico TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
9	46	46	N/A	I-40, Holy Moses Wash Bridges deck design rehabilitation.	√			FY 2017	H872801C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
10	47	49	2	Climbing lane EB. Noted as a Tier 2 project – medium priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
11	49	49	N/A	I-40, West Kingman TI Interim improvements (spot safety improvements).		√		FY 2016	H874401C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
12	49	49	N/A	I-40/US 93 system interchange			√	N/A	N/A	Y	Final DCR, June 2015
13	49	53	4	New noise barriers		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
14	55	56	1	New Kingman Crossing traffic interchange			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study Kingman PARA DCR and CE completed in 2010
15	57	57	N/A	New Rancho Santa Fe Parkway (formerly Rattlesnake Wash) Traffic Interchange			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study Kingman PARA
16	58	60	2	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
17	59	59	N/A	Reconstruct DW Ranch Rd TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
18	59	59	N/A	DW Ranch Rd TI Underpass #1249 bridge deck rehabilitation	√			FY 2017	H879901C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
19	66	66	N/A	Blake Ranch Road TI Improvements		√		FY 2017	H751302C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
20	72	72	N/A	New WB Dynamic Message Sign		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
21	72	72	N/A	I-40/US 93 system interchange			√	N/A	N/A	N	Statewide Dynamic Message Sign Strategic Plan
22	72	80	8	Pavement preservation - Junction US-93 Silver Springs Road	√			FY 2016	H860401C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020

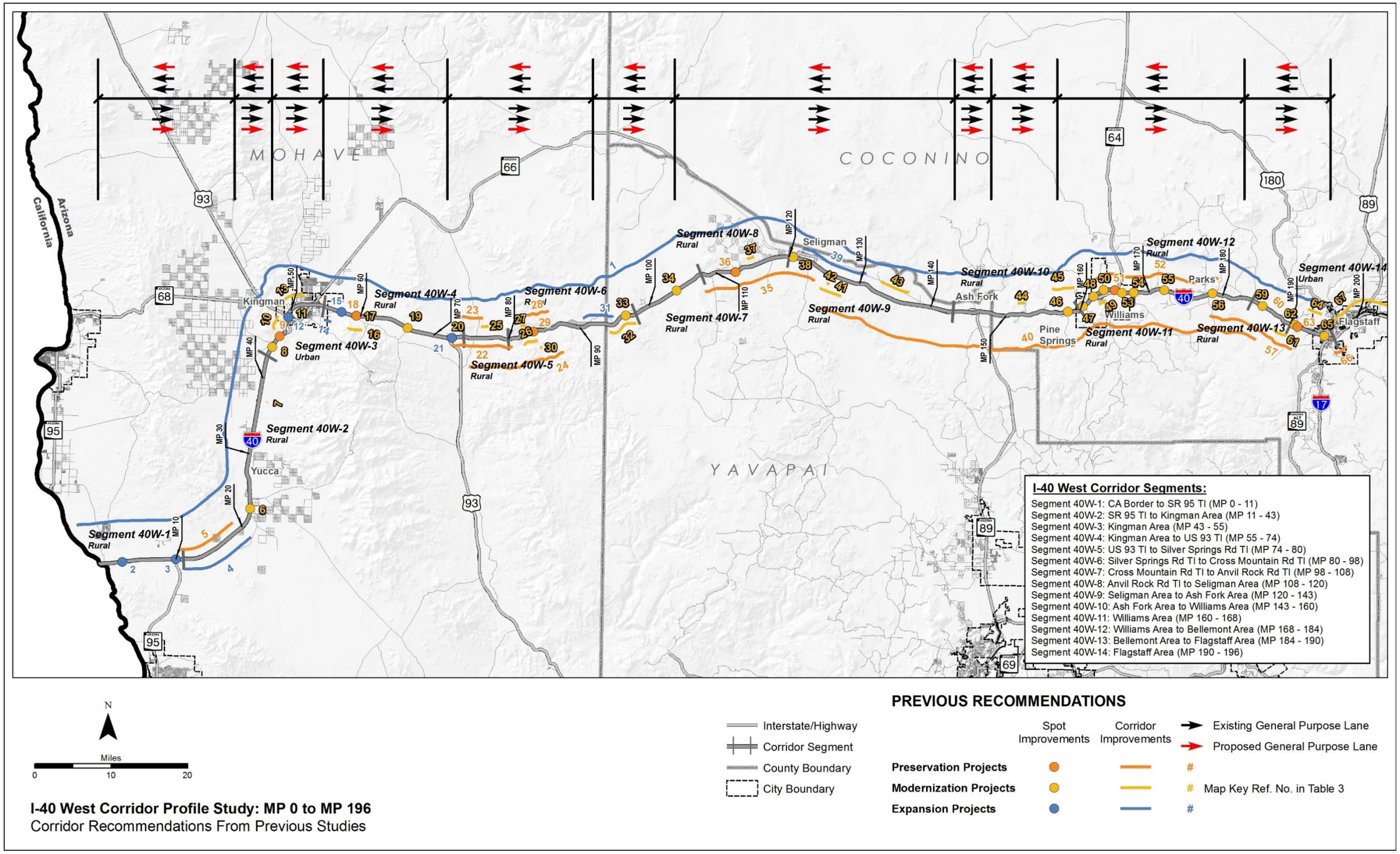
Table 3: Corridor Recommendations from Previous Studies (continued)

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
23	73	76	3	Bridge deck rehabilitation and scour retrofit - Peacock Wash WB structure #1251 & Big Sandy WB structure #1253	√			FY 2018	H842001C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
24	74	87	13	Pavement Preservation, Junction US 93 to Willow TI	√			FY 2019	H893201C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
25	76	77	1	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
26	81	83	2	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
27	81.5	82.2	0.7	Climbing lane WB		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
28	83	86	3	Bridge deck rehabilitation EB Str # 1592, 1594, 1595, and 1768	√			FY 2016	H861301C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
29	83	83	N/A	Rockfall Mitigation - Willow Springs	√			FY 2017	H880101C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
30	83.7	84	0.3	Climbing lane WB		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
31	90	94	4	New rest area			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
32	93	97	4	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
33	96.02	96.02	N/A	Reconstruct Cross Mountain TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
34	103.58	103.58	N/A	Reconstruct Jolly Road TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
35	108	123	15	Pavement preservation, Markham Wash to East 40B (WB)	√			FY 2019	H893301C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
36	112	112	N/A	Audley Overpass EB Str #1520 and WB Str #1521 – bridge deck rehabilitation	√			FY 2017	H882001C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
37	114	115	1	Climbing lane WB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
38	120	120		New WB Dynamic Message Sign		√		N/A	N/A	N	Statewide Dynamic Message Sign Strategic Plan
39	121	130	9	New traffic interchange			√	N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
40	125	185	60	Sign rehabilitation, Crookton to Transwestern	√			FY 2017	H870301C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
41	125	128	3	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
42	125.5	125.9	0.4	Climbing lane WB		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
43	132	136	4	Climbing lane WB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
44	151	152	1	Climbing lane EB. Noted as a Tier 2 project – medium priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
45	156	159	3	Climbing lane EB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
46	157.77	157.77	N/A	Reconstruct Devil Dog TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
47	160	160	N/A	New EB Dynamic Message Sign		√		N/A	N/A	N	Statewide Dynamic Message Sign Strategic Plan
48	161.96	161.96	N/A	Reconstruct West Williams TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
49	162	163	1	Climbing lane WB. Noted as a Tier 3 project – low priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
50	163.54	163.54	N/A	Reconstruct Grand Canyon Blvd TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study

Table 3: Corridor Recommendations from Previous Studies (continued)

Map Key Ref. #	Begin MP	End MP	Length (miles)	Project Description	Investment Category (Preservation [P], Modernization [M], Expansion [E])			Status of Recommendation			Name of Study
					P	M	E	Program Year	Project No.	Environmental Documentation (Y/N)?	
51	165	165	N/A	E. Williams RR Overpass, structure # EB 1911 & WB #1912 - Bridge deck rehabilitation	√			FY 2019	H872701C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
52	162	179	17	Pavement preservation, Cataract Lake Road to Parks TI	√			FY 2018	H879401C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
53	166	166	N/A	Reconstruct East Williams TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
54	167.52	167.52	N/A	Reconstruct Garland TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
55	171.65	171.65	N/A	Reconstruct Pittman TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
56	178.18	178.18	N/A	Reconstruct Parks TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
57	179	191	12	Pavement preservation - Parks TI - Riordan Bridge	√			FY 2019	H879501C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
59	185.11	185.11	N/A	Reconstruct Transwestern TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
60	188	189	1	Riordan Rockfall Mitigation design	√			FY 2016	H881401D	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
61	188	190	2	Climbing lane EB. Noted as a Tier 1 project – high priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
62	190.54	190.54	N/A	Reconstruct A-1 Mountain TI		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
63	191	191	N/A	West Flagstaff TI overpass structure EB # 1128 and WB #1129 – bridge deck rehabilitation	√			FY 2019	H877701C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
64	191	193	2	Climbing lane WB. Noted as a Tier 2 project – medium priority		√		N/A	N/A	N	2015 Climbing and Passing Lane Prioritization Study
65	194.7	194.7	N/A	Climbing lane WB		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study
66	195	197	2	I-17/I-40 Interchange, Structures #1261-#1264 –bridge deck rehabilitation.	√			FY 2017	H877501C	N	Five Year Transportation Facilities Construction Program FY 2016-FY 2020
67	195	205	10	New noise barriers		√		N/A	N/A	N	1999 I-40 Multimodal Corridor Profile Study

Figure 4: Corridor Recommendations from Previous Studies



I-40 West Corridor Profile Study: MP 0 to MP 196
Corridor Recommendations From Previous Studies

2.0 CORRIDOR PERFORMANCE

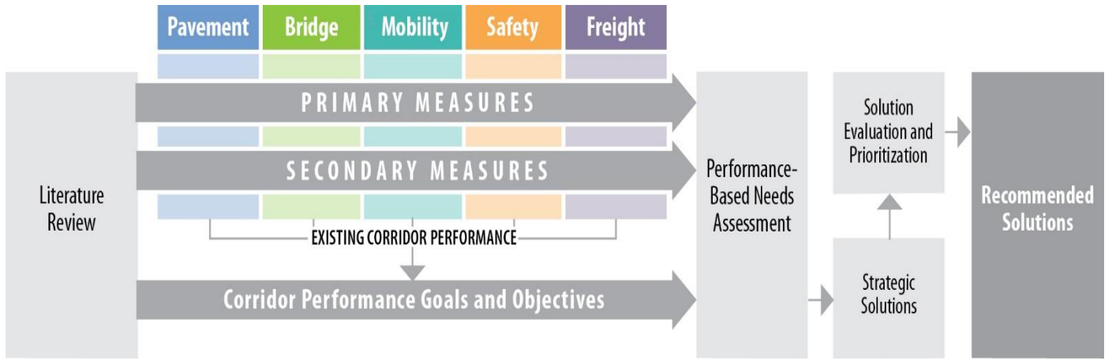
This chapter describes the evaluation of the existing performance of the I-40 West corridor. A series of performance measures is used to assess the corridor. The results of the performance evaluation are used to define corridor needs relative to the long-term goals and objectives for the corridor.

2.1 Corridor Performance Framework

This study uses a performance-based process to define baseline corridor performance, diagnose corridor needs, develop corridor solutions, and prioritize strategic corridor investments. In support of this objective, a framework for the performance-based process was developed through a collaborative process involving ADOT and the CPS consultant teams.

Figure 5 illustrates the performance framework, which includes a two-tiered system of performance measures (primary and secondary) to evaluate baseline performance. The primary measures in each of five performance areas are used to define the overall health of the corridor, while the secondary measures identify locations that warrant further diagnostic investigation to delineate needs. Needs are defined as the difference between baseline corridor performance and established performance objectives.

Figure 5: Corridor Profile Performance Framework



The following five performance areas guide the performance-based corridor analyses:

- Pavement
- Bridge
- Mobility
- Safety
- Freight

These performance areas reflect national performance goals stated in *Moving Ahead for Progress in the 21st Century* (MAP-21):

- Safety: To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
- Infrastructure Condition: To maintain the highway infrastructure asset system in a state of good repair
- Congestion Reduction: To achieve a significant reduction in congestion on the National Highway System
- System Reliability: To improve the efficiency of the surface transportation system
- Freight Movement and Economic Vitality: To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
- Environmental Sustainability: To enhance the performance of the transportation system while protecting and enhancing the natural environment
- Reduced Project Delivery Delays: To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion

The MAP-21 performance goals were considered in the development of ADOT's P2P process, which integrates transportation planning with capital improvement programming and project delivery. Because the P2P program requires the preparation of annual transportation system performance reports using the five performance areas adopted for the CPS, consistency is achieved in the performance measures used for various ADOT analysis processes.

The performance measures include five primary measures: Pavement Index, Bridge Index, Mobility Index, Safety Index, and Freight Index. Additionally, a set of secondary performance measures provides for a more detailed analysis of corridor performance.

Each of the primary and secondary performance measures is comprised of one or more quantifiable indicators. A three-level scale was developed to standardize the performance scale across the five performance areas, with numerical thresholds specific to each performance measure:

Good/Above Average Performance – Rating is above the identified desirable/average range

Fair/Average Performance – Rating is within the identified desirable/average range

Poor/Below Average Performance – Rating is below the identified desirable/average range

Table 4 provides the complete list of primary and secondary performance measures for each of the five performance areas.

Table 4: Corridor Performance Measures

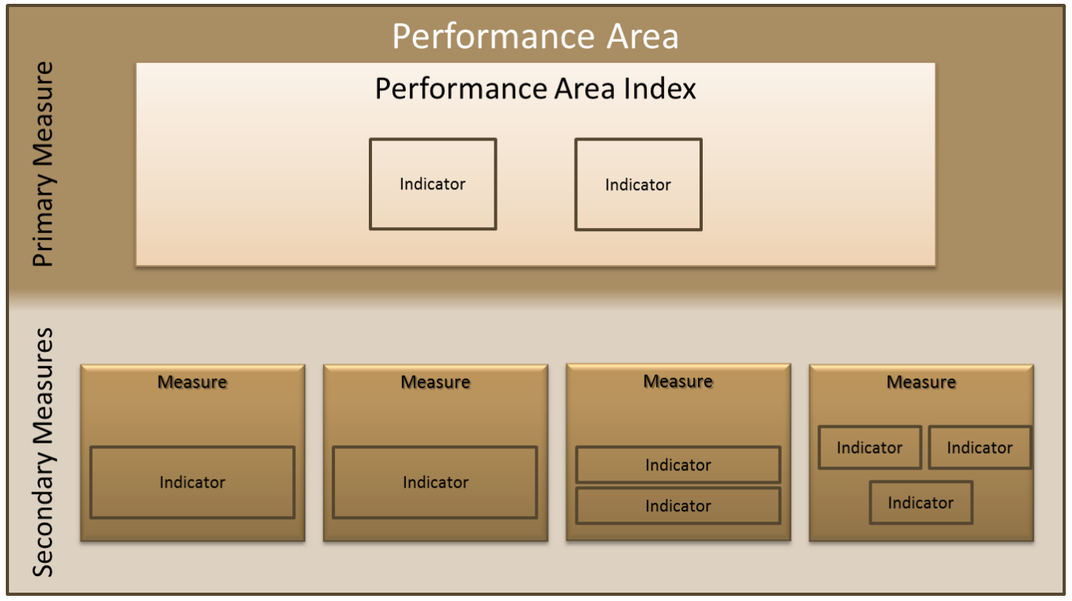
Performance Area	Primary Measure	Secondary Measures
Pavement	**Pavement Index** Based on a combination of International Roughness Index and cracking	• Directional Pavement Serviceability • Pavement Failure • Pavement Hot Spots
Bridge	**Bridge Index** Based on lowest of deck, substructure, superstructure and structural evaluation rating	• Bridge Sufficiency • Functionally Obsolete Bridges • Bridge Rating • Bridge Hot Spots
Mobility	**Mobility Index** Based on combination of existing and future daily volume-to-capacity ratios	• Future Congestion • Peak Congestion • Travel Time Reliability • Multimodal Opportunities
Safety	**Safety Index** Based on frequency of fatal and incapacitating injury crashes	• Directional Safety Index • Strategic Highway Safety Plan Emphasis Areas • Crash Unit Types • Safety Hot Spots
Freight	**Freight Index** Based on bi-directional truck planning time index	• Recurring Delay • Non-Recurring Delay • Closure Duration • Bridge Vertical Clearance • Bridge Vertical Clearance Hot Spots

The general template for each performance area is illustrated in **Figure 6**.

The guidelines for performance measure development are:

- Indicators and performance measures for each performance area should be developed for relatively homogeneous corridor segments
- Performance measures for each performance area should be tiered, consisting of primary measure(s) and secondary measure(s)
- Primary and secondary measures should assist in identifying those corridor segments that warrant in-depth diagnostic analyses to identify performance-based needs and a range of corrective actions known as solution sets
- One or more primary performance measures should be used to develop a Performance Index to communicate the overall health of a corridor and its segments for each performance area; the Performance Index should be a single numerical index that is quantifiable, repeatable, scalable, and capable of being mapped; primary performance measures should be transformed into a Performance Index using mathematical or statistical methods to combine one or more data fields from an available ADOT database
- One or more secondary performance measure indicators should be used to provide additional details to define corridor locations that warrant further diagnostic analysis; secondary performance measures may include the individual indicators used to calculate the Performance Index and/or “hot spot” features

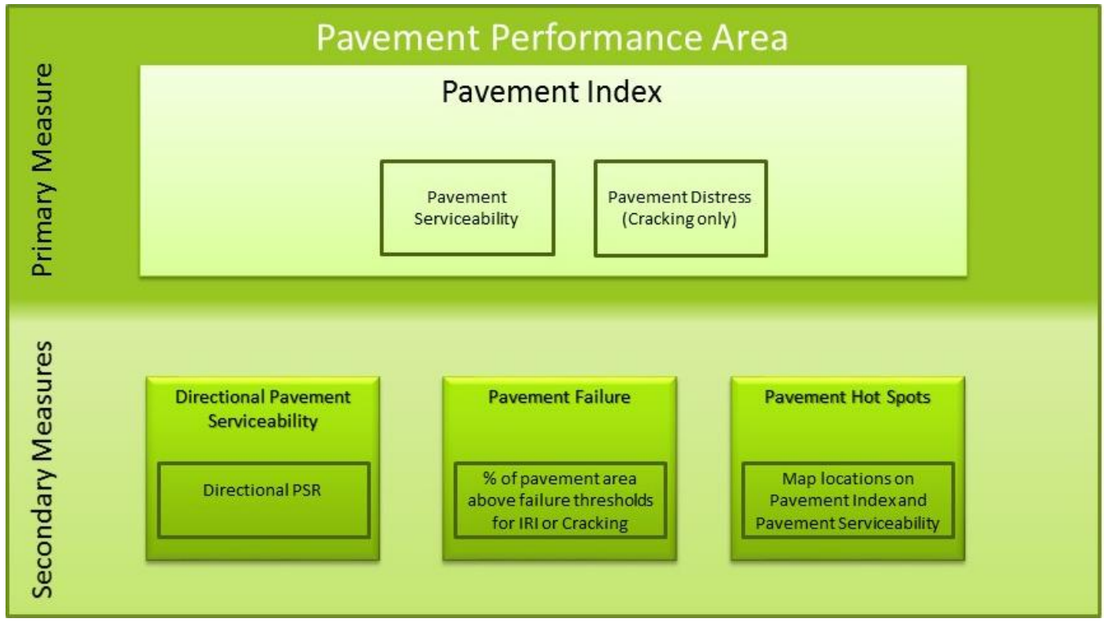
Figure 6: Performance Area Template



2.2 Pavement Performance Area

The Pavement performance area consists of a primary measure (Pavement Index) and three secondary measures, as shown in **Figure 7**. These measures assess the condition of the existing pavement along the I-40 West corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 7: Pavement Performance Measures



Primary Pavement Index

The Pavement Index is calculated using two pavement condition ratings: the Pavement Serviceability Rating (PSR) and the Pavement Distress Index (PDI).

The PSR is extracted from the International Roughness Index (IRI), a measurement of pavement roughness based on field-measured longitudinal roadway profiles. The PDI is extracted from the Cracking Rating (CR), a field-measured sample from each mile of highway.

Both the PSR and PDI use a 0 to 5 scale with 0 representing the lowest performance and 5 representing the highest. The Pavement Index for each segment is a weighted average of the directional ratings based on the number of travel lanes. Therefore, the condition of a section with more travel lanes will have a greater influence on the resulting segment Pavement Index than the condition of a section with fewer travel lanes.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Pavement performance area, the relevant operating environments are designated as interstate and non-interstate segments. For the I-40 West corridor, the following operating environment was identified:

- Interstate: all segments

Secondary Pavement Measures

Three secondary measures provide an in-depth evaluation of the different characteristics of pavement performance.

Directional Pavement Serviceability

- Weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel

Pavement Failure

- Percentage of pavement area rated above failure thresholds for IRI or Cracking

Pavement Hot Spots

- A Pavement “hot spot” exists where a given one-mile section of roadway rates as being in “poor” condition
- Highlights problem areas that may be under-represented in a segment average. This measure is recorded and mapped, but not included in the Pavement performance area rating calculations

Pavement Performance Results

The Pavement Index provides a high-level assessment of the pavement condition for the corridor and for each segment. The three secondary measures provide more detailed information to assess pavement performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Pavement Index shows “good” performance for the I-40 West corridor
- Six segments show “fair” performance for Pavement Index ratings while Segments 40W-4 and 40W-13 show “poor” performance
- Many of these same segments show “fair” or “poor” performance for the Directional PSR ratings
- The weighted average of % Area Failure shows “poor” performance for the corridor
- Segments 40W-4, 5, 6, 10, 11, 13, and 14 all show “poor” performance for the % Area Failure ratings
- Pavement hot spots include the following by segment:
  - Segment 40W-1 EB MP 3-4
  - Segment 40W-2 WB 41-42

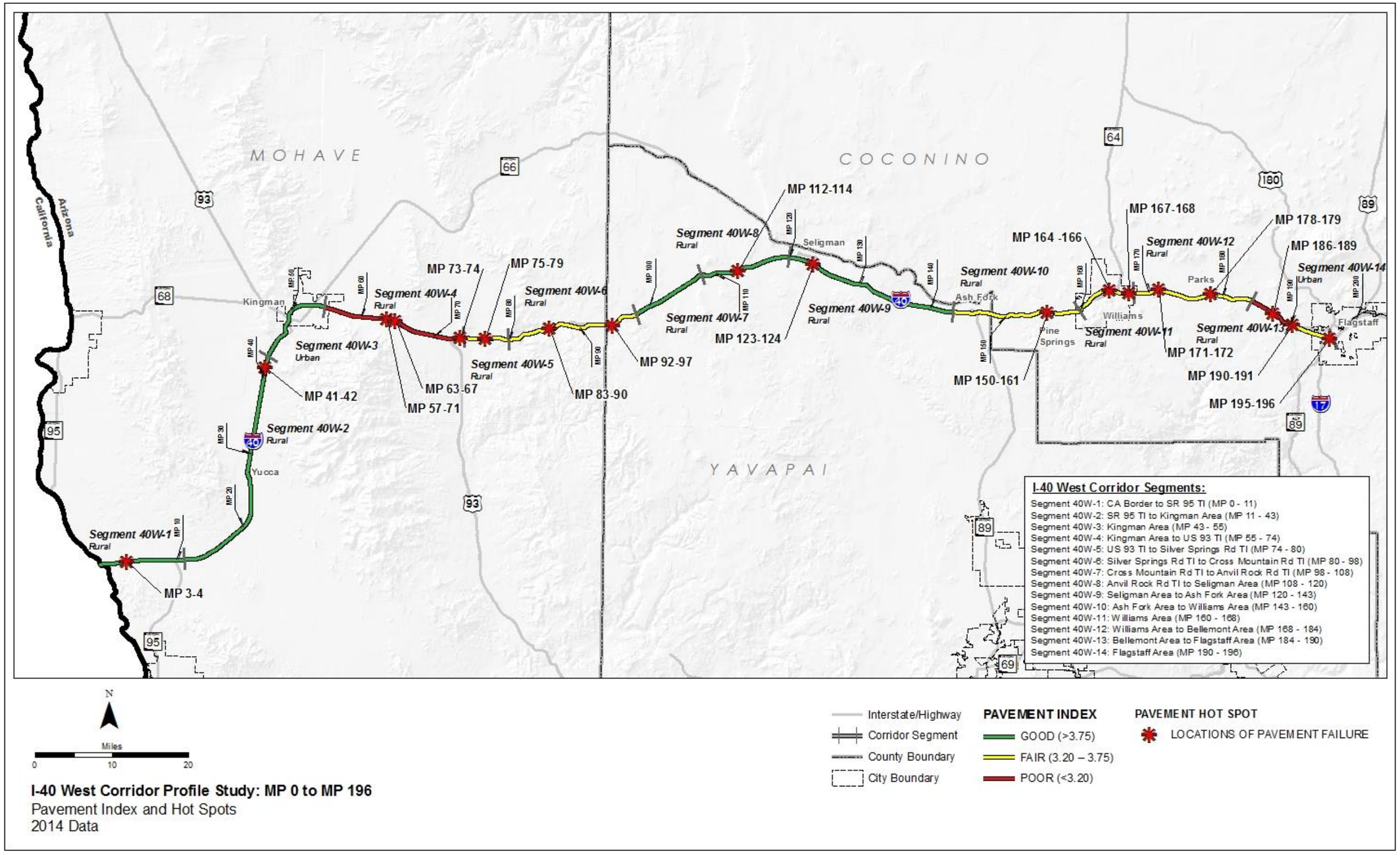
- Segment 40W-4 EB MP 57-71, WB MP 63-67 and MP 73-74
- Segment 40W-5 WB MP 75-79
- Segment 40W-6 EB MP 83-90 and MP92-93, WB MP 82-84, MP 85-87, MP 88-90, and MP 92-97
- Segment 40W-8 EB MP 112-113, WB MP 113-114
- Segment 40W-9 EB MP 123-124
- Segment 40W-10 EB MP 150-155 and MP 156-160, WB MP 152-159
- Segment 40W-11 EB 160-161, MP 164-166, and MP 167-168, WB MP 167-168
- Segment 40W-12 EB MP 178-179, WB MP 171-172 and MP 178-179
- Segment 40W-13 EB MP 186-189, WB 187-189
- Segment 40W-14 EB MP 190-191, WB 190-191 and 195-196

Table 5 summarizes the Pavement performance results for the I-40 West corridor. **Figure 8** illustrates the primary Pavement Index performance and locations of Pavement hot spots along the I-40 West corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 5: Pavement Performance

Segment #	Segment Length (miles)	Pavement Index	Directional PSR		% Area Failure
			EB	WB	
40W-1	11	4.10	4.03	4.12	5%
40W-2	32	4.38	4.29	4.21	2%
40W-3	12	4.11	4.06	4.04	0%
40W-4	19	3.20	3.10	3.48	48%
40W-5	6	3.64	4.15	3.20	33%
40W-6	18	3.20	3.41	3.22	54%
40W-7	10	3.94	3.84	3.95	0%
40W-8	12	4.09	4.02	3.98	8%
40W-9	23	4.27	3.93	4.24	2%
40W-10	17	3.64	3.50	3.55	48%
40W-11	8	3.26	3.54	3.63	31%
40W-12	16	3.60	3.76	3.94	9%
40W-13	6	2.85	3.73	3.52	42%
40W-14	6	3.73	3.87	3.73	28%
Weighted Corridor Average		3.81	3.81	3.84	20%
SCALES					
Performance Level		**Interstate**			
Good		> 3.75			< 5%
Fair		3.20 - 3.75			5% - 20%
Poor		< 3.20			> 20%

Figure 8: Pavement Performance

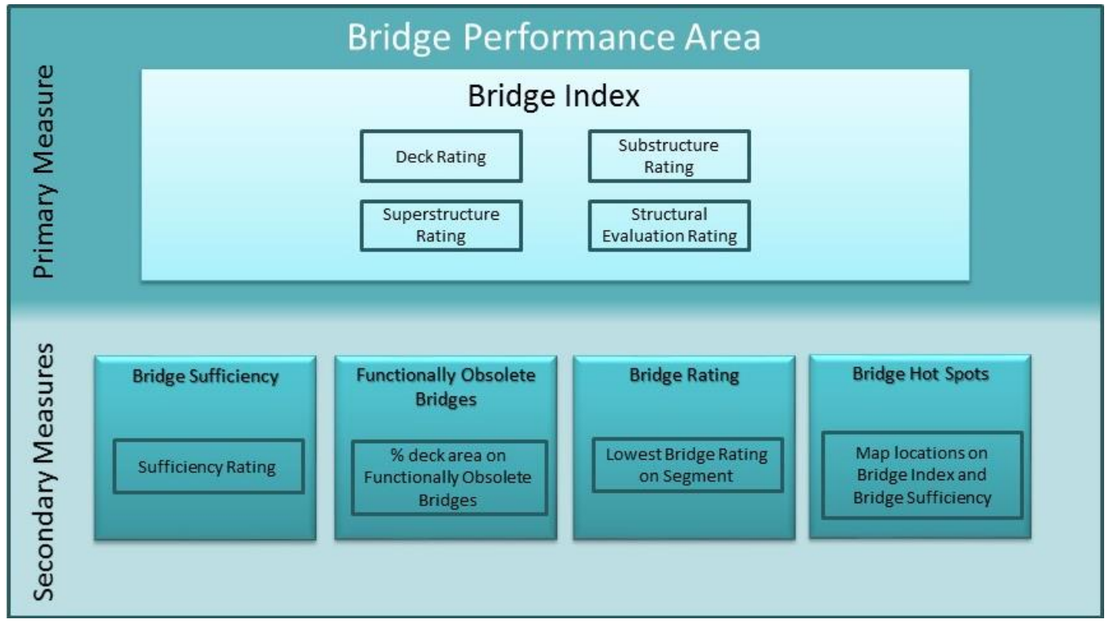


I-40 West Corridor Profile Study: MP 0 to MP 196
Pavement Index and Hot Spots
2014 Data

2.3 Bridge Performance Area

The Bridge performance area consists of a primary measure (Bridge Index) and four secondary measures, as shown in **Figure 9**. These measures assess the condition of the existing bridges along the I-40 West corridor. Only bridges that carry mainline traffic or bridges that cross the mainline are included in the calculation. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 9: Bridge Performance Measures



Primary Bridge Index

The Bridge Index is calculated based on the use of four different bridge condition ratings from the ADOT Bridge Database, also known as the Arizona Bridge Information and Storage System (ABISS). The four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating. These ratings are based on inspection reports and establish the structural adequacy of each bridge. The performance of each individual bridge is established by using the lowest of these four ratings. The use of these ratings, and the use of the lowest rating, is consistent with the approach used by the ADOT Bridge Group to assess the need for bridge rehabilitation. The Bridge Index is calculated as a weighted average for each segment based on deck area.

Secondary Bridge Measures

Four secondary measures provide an in-depth evaluation of the characteristics of each bridge:

Bridge Sufficiency

- Multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour
- Rates the structural and functional sufficiency of each bridge on a 100-point scale

Functionally Obsolete Bridges

- Percentage of total deck area in a segment that is on functionally obsolete bridges
- Identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails
- A bridge that is functionally obsolete may still be structurally sound

Bridge Rating

- The lowest rating of the four bridge condition ratings (substructure, superstructure, deck, and structural evaluation) on each segment
- Identifies lowest performing evaluation factor on each bridge

Bridge Hot Spots

- A Bridge “hot spot” is identified where a given bridge has a bridge rating of 4 or lower or multiple ratings of 5 between the deck, superstructure, and substructure ratings
- Identifies particularly low-performing bridges or those that may decline to low performance in the immediate future

Bridge Performance Results

The Bridge Index provides a high-level assessment of the structural condition of bridges for the corridor and for each segment. The four secondary measures provide more detailed information to assess bridge performance.

Based on the results of this analysis, the following observations were made:

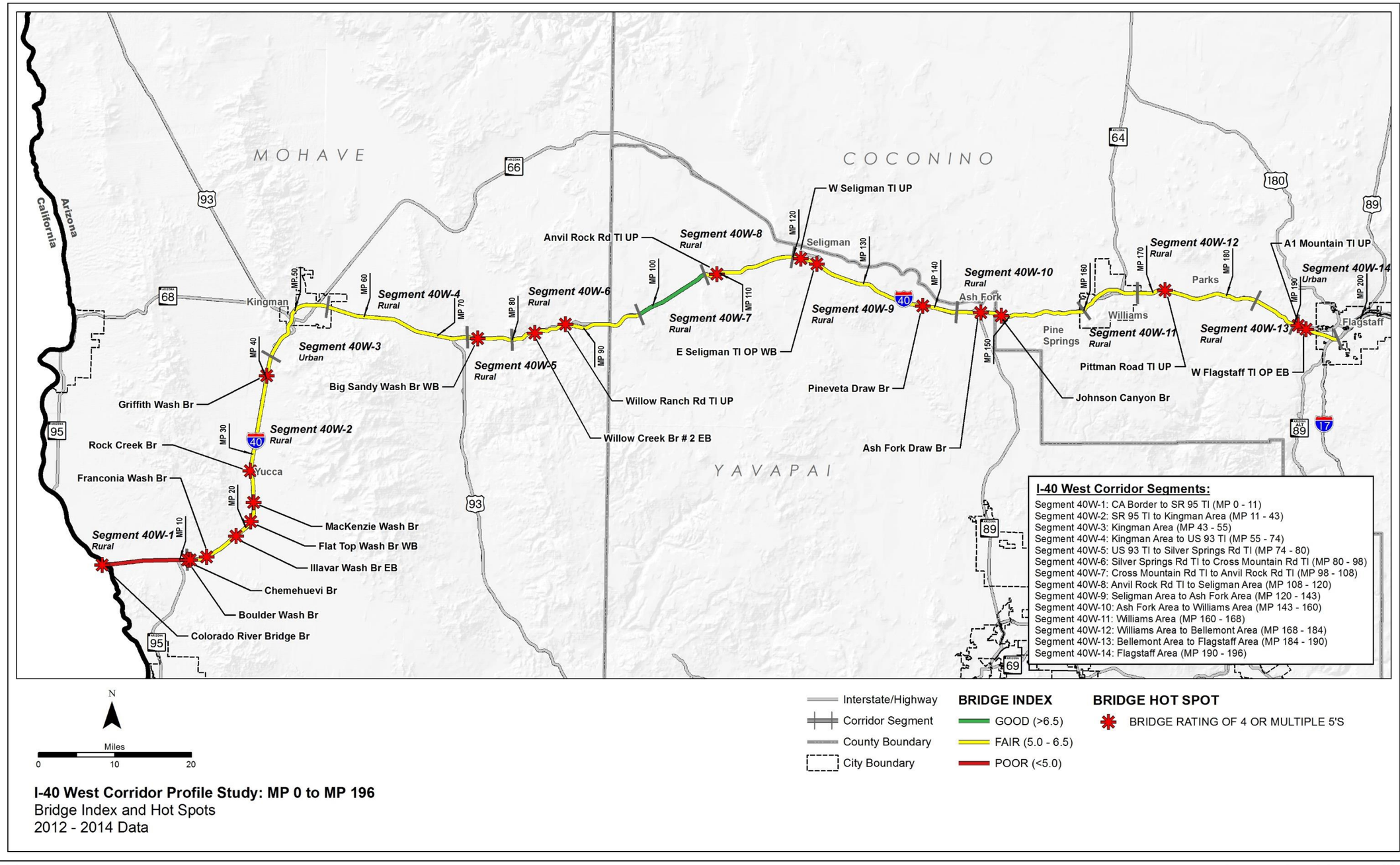
- The weighted average of the Bridge Index shows “fair” performance for the I-40 West corridor
- The Bridge Index predominantly shows “fair” performance, with the exception of Segments 40W-1 and 40W-7, where the Bridge Index shows “poor” performance and “good” performance, respectively
- The corridor has “poor” performance based on the weighted corridor average of Lowest Bridge Rating; Segment 40W-1 includes the Colorado River Bridge with a Lowest Bridge Rating of 3
- Every segment along I-40 West shows “good” performance for Bridge Sufficiency
- Segments 40W-8, 10, and 12 show “poor” performance in the % of Deck Area on Functionally Obsolete Bridges area; all other segments show “fair” or “good” performance
- There are numerous Bridge hot spots along the corridor, as shown in **Figure 10**

Table 6 summarizes the Bridge performance results for the I-40 West corridor. **Figure 10** illustrates the primary Bridge Index performance and locations of Bridge hot spots along the I-40 West corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 6: Bridge Performance

Segment #	Segment Length (miles)	# of Bridges	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating
40W-1	11	4	3.66	81.10	6%	3
40W-2	32	35	5.78	90.49	6%	4
40W-3	12	19	5.80	95.02	19%	5
40W-4	19	10	5.59	93.41	24%	5
40W-5	6	6	5.13	94.85	21%	4
40W-6	18	12	5.36	87.52	3%	4
40W-7	10	3	6.72	95.52	0%	6
40W-8	12	5	5.71	90.38	49%	4
40W-9	23	8	5.21	87.19	0%	4
40W-10	17	17	5.37	91.34	40%	4
40W-11	8	16	5.81	95.07	24%	5
40W-12	16	4	5.27	80.51	80%	5
40W-13	6	2	5.50	97.11	0%	5
40W-14	6	11	5.11	90.05	0%	4
Weighted Corridor Average			5.53	91.23	17%	4.35
SCALES						
Performance Level			**All**			
Good			> 6.5	> 80	< 12%	> 6
Fair			5.0 - 6.5	50 - 80	12% - 40%	5 - 6
Poor			< 5.0	< 50	> 40 %	< 5

Figure 10: Bridge Performance

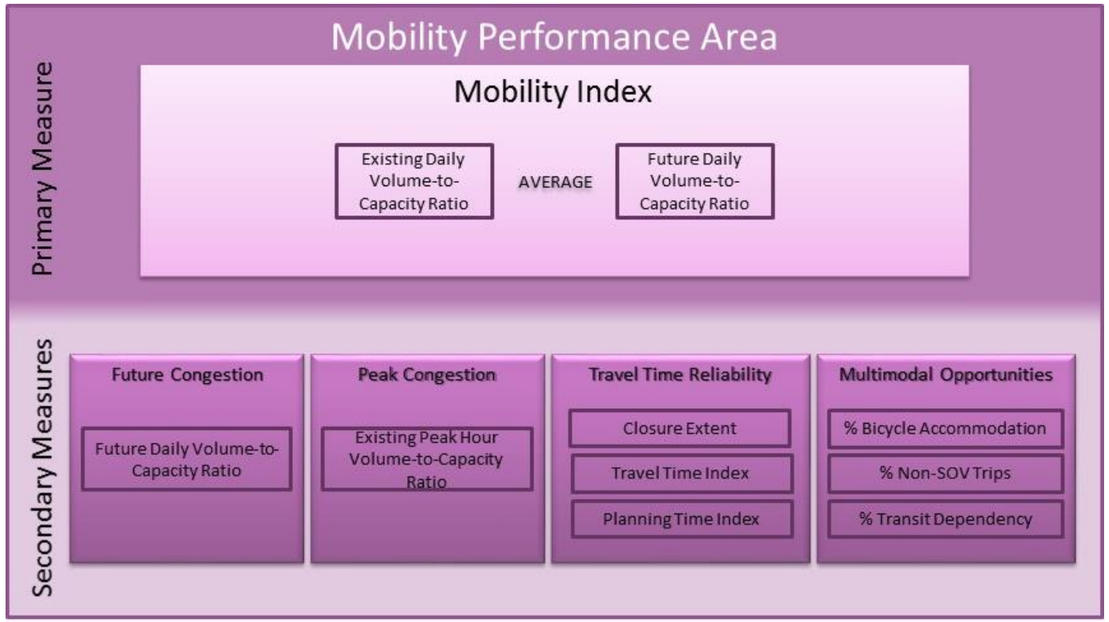


I-40 West Corridor Profile Study: MP 0 to MP 196
Bridge Index and Hot Spots
2012 - 2014 Data

2.4 Mobility Performance Area

The Mobility performance area consists of a primary measure (Mobility Index) and four secondary measures, as shown in **Figure 11**. These measures assess the condition of existing mobility along the I-40 West corridor. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 11: Mobility Performance Measures



Primary Mobility Index

The Mobility Index is an average of the existing (2014) daily volume-to-capacity (V/C) ratio and the future (2035 AZTDM) daily V/C ratio for each segment of the corridor. The V/C ratio is an indicator of the level of congestion. This measure compares the average annual daily traffic (AADT) volume to the capacity of the corridor segment as defined by the service volume for level of service (LOS) E. By using the average of the existing and future year daily volumes, this index measures the level of daily congestion projected to occur in approximately ten years (2025) if no capacity improvements are made to the corridor.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Mobility performance area, the relevant operating environments are urban vs. rural setting and interrupted flow (e.g., signalized at-grade intersections are present) vs. uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway). For the I-40 West corridor, the following operating environments were identified:

- Urban Uninterrupted Flow: Segments 40W-3 and 14
- Rural Uninterrupted Flow: Segments 40W-1, 2, and 4 through 13

Secondary Mobility Measures

Four secondary measures provide an in-depth evaluation of operational characteristics of the corridor:

Future Congestion – Future Daily V/C

- The future (2035 AZTDM) daily V/C ratio. This measure is the same value used in the calculation of the Mobility Index
- Provides a measure of future congestion if no capacity improvements are made to the corridor

Peak Congestion – Existing Peak Hour V/C

- The peak hour V/C ratio for each direction of travel
- Provides a measure of existing peak hour congestion during typical weekdays

Travel Time Reliability– Three separate travel time reliability indicators together provide a comprehensive picture of how much time may be required to travel within the corridor:

- Closure Extent:
  - The average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average was applied to each closure that takes into account the distance over which the closure occurs
  - Closures related to crashes, weather, or other incidents are a significant contributor to non-recurring delays; construction-related closures were excluded from the analysis
- Directional Travel Time Index (TTI):
  - The ratio of the average peak period travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The TTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- Directional Planning Time Index (PTI):
  - The ratio of the 95th percentile travel time to the free-flow travel time (based on the posted speed limit) in a given direction
  - The PTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

- The PTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

Multimodal Opportunities – Three multimodal opportunity indicators reflect the characteristics of the corridor that promote alternate modes to the single occupancy vehicle (SOV) for trips along the corridor:

- % Bicycle Accommodation:
  - Percentage of the segment that accommodates bicycle travel; bicycle accommodation on the roadway or on shoulders varies depending on traffic volumes, speed limits, and surface type
  - Encouraging bicycle travel has the potential to reduce automobile travel, especially on non-interstate highways
- % Non-SOV Trips:
  - The percentage of trips (less than 50 miles in length) by non-SOVs
  - The percentage of non-SOV trips in a corridor gives an indication of travel patterns along a section of roadway that could benefit from additional multimodal options
- % Transit Dependency:
  - The percentage of households that have zero or one automobile and households where the total income level is below the federally defined poverty level
  - Used to track the level of need among those who are considered transit dependent and more likely to utilize transit if it is available

Mobility Performance Results

The Mobility Index provides a high-level assessment of mobility conditions for the corridor and for each segment. The four secondary measures provide more detailed information to assess mobility performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Mobility Index shows “good” performance for the I-40 West corridor
- The Future Daily V/C and Directional Existing Peak Hour V/C indicators show “good” performance for each segment of the corridor
- Segments 40W-5 through 40W-10 show “poor” performance for EB Closure Extents, with a majority of the remaining segments showing “fair” performance; the WB direction performs much better with Segments 40W-10 through 40W-13 showing “fair” performance and the remaining segments show “good” performance
- The Directional TTI measures show either “good” or “fair” performance throughout each segment of the corridor
- The Directional PTI measures show “fair” or “poor” performance throughout the majority of the corridor; Segments 40W-3, 4, 5, and 10 show poor performance for both Directional PTI measures
- % Non-SOV Trips show “poor” or “fair” performance throughout the corridor with the exception of Segment 40W-3, which shows “good” performance
- All segments show good performance for % Bicycle Accommodation with the exception of Segment 40W-2, which shows “poor” performance

Table 7 summarizes the Mobility performance results for the I-40 West corridor. **Figure 12** illustrates the primary Mobility Index performance along the I-40 West corridor. Maps for each secondary measure can be found in **Appendix A**.

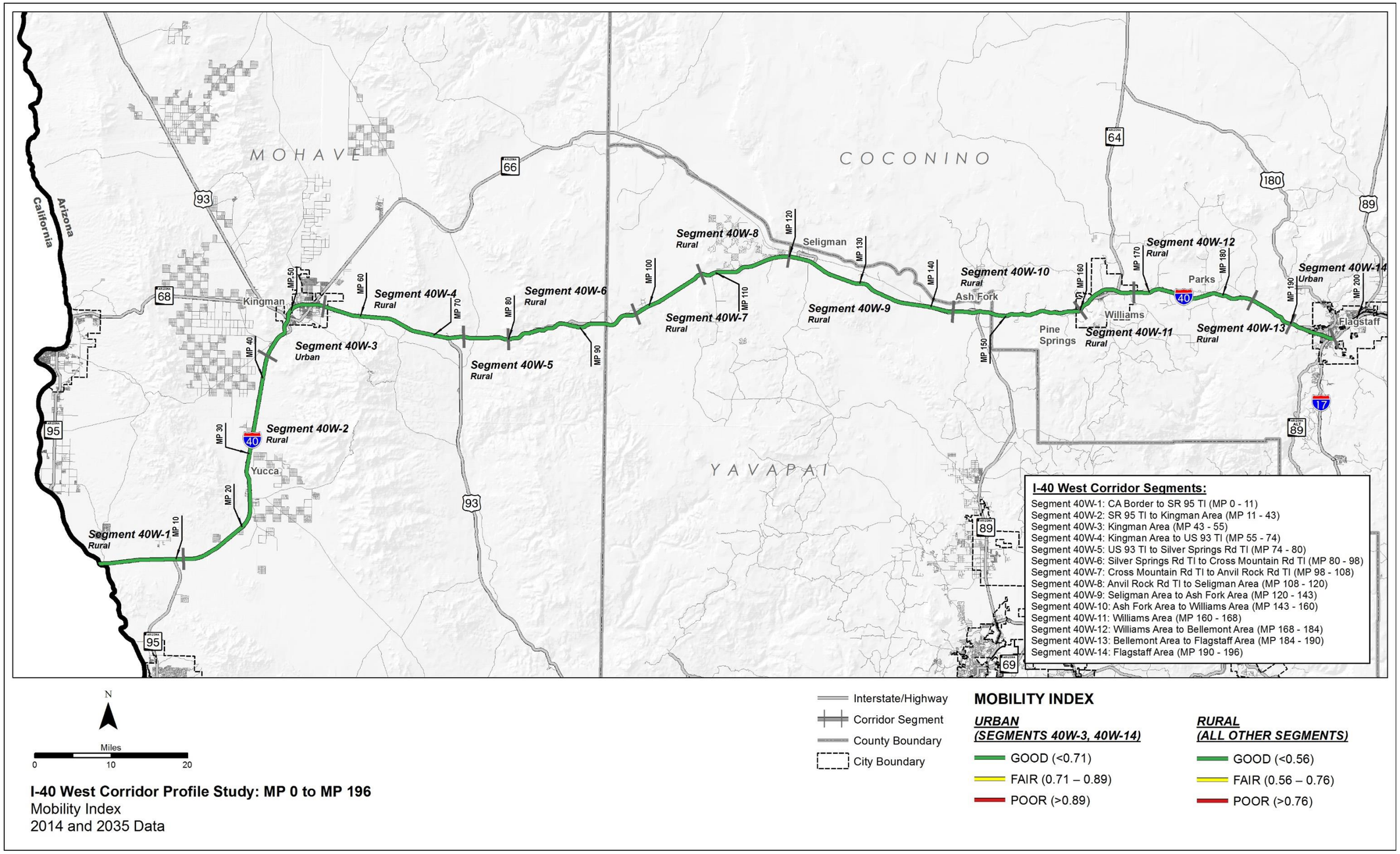
Table 7: Mobility Performance

Segment #	Segment Length (miles)	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
				EB	WB	EB	WB	EB	WB	EB	WB		
40W-1[2]	11	0.28	0.39	0.18	0.18	0.15	0.05	1.23	1.10	1.56	1.28	98%	9.8%
40W-2[2]	32	0.29	0.40	0.19	0.19	0.16	0.09	1.12	1.09	1.29	1.22	50%	10.7%
40W-3[1]	12	0.41	0.53	0.27	0.27	0.28	0.12	1.22	1.14	1.72	1.56	92%	19.0%
40W-4[2]	19	0.19	0.16	0.19	0.19	0.37	0.17	1.16	1.15	1.69	1.54	100%	12.5%
40W-5[2]	6	0.28	0.38	0.13	0.13	1.40	0.00	1.27	1.20	1.68	1.57	100%	6.2%
40W-6[2]	18	0.25	0.34	0.13	0.12	1.20	0.12	1.24	1.10	1.64	1.27	100%	6.8%
40W-7[2]	10	0.27	0.37	0.15	0.15	1.06	0.00	1.13	1.08	1.31	1.22	100%	6.8%
40W-8[2]	12	0.29	0.40	0.16	0.15	1.07	0.12	1.09	1.14	1.23	1.37	100%	13.8%
40W-9[2]	23	0.31	0.42	0.15	0.15	0.89	0.05	1.13	1.12	1.39	1.34	100%	10.8%
40W-10[2]	17	0.31	0.43	0.13	0.13	0.71	0.59	1.31	1.16	1.98	1.65	100%	12.3%
40W-11[2]	8	0.32	0.44	0.14	0.14	0.55	0.30	1.16	1.12	1.40	1.36	100%	8.1%
40W-12[2]	16	0.30	0.38	0.14	0.14	0.45	0.25	1.11	1.13	1.28	1.46	98%	8.3%
40W-13[2]	6	0.34	0.43	0.21	0.21	0.53	0.23	1.11	1.12	1.30	1.33	98%	12.4%
40W-14[1]	6	0.51	0.67	0.27	0.27	0.53	0.13	1.04	1.14	1.20	1.36	99%	16.1%
Weighted Corridor Average		0.30	0.39	0.17	0.17	0.62	0.16	1.17	1.12	1.48	1.38	91%	10.9%

SCALES						
Performance Level	**Urban Rural**	**All**	**Uninterrupted**		**All**	
Good	< 0.71[1] < 0.56[2]	< 0.22	< 1.15	< 1.30	> 90%	> 17%
Fair	0.71 - 0.89[1] 0.56 - 0.76[2]	0.22 – 0.62	1.15 - 1.33	1.30 - 1.50	60% - 90%	11% - 17%
Poor	> 0.89[1] > 0.76[2]	> 0.62	> 1.33	> 1.50	< 60%	< 11%

[1]Urban Operating Environment
[2]Rural Operating Environment

Figure 12: Mobility Performance

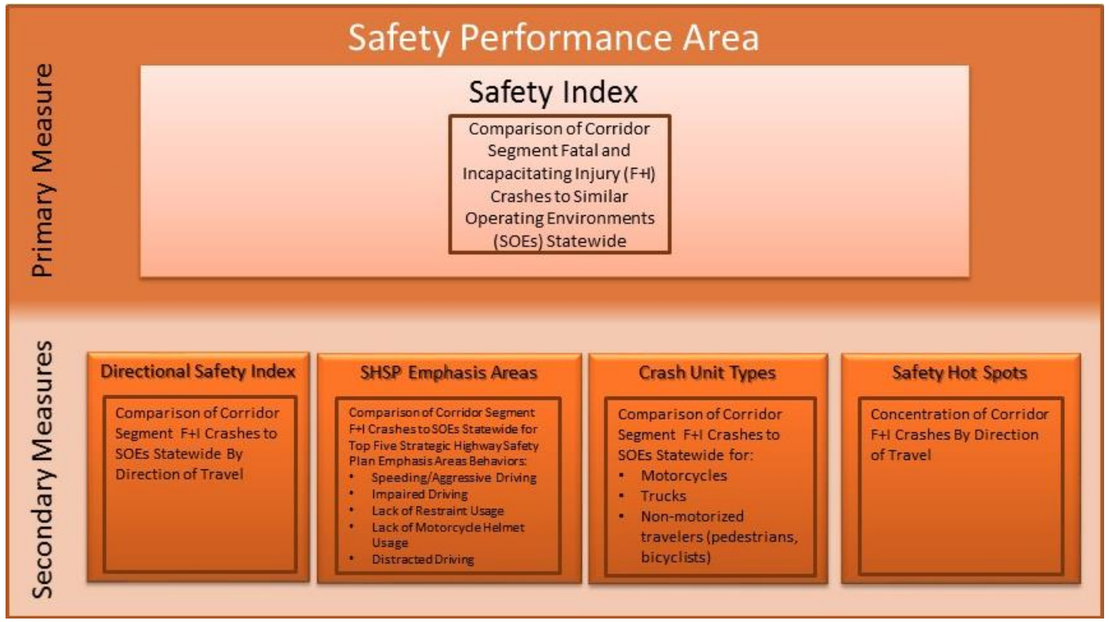


I-40 West Corridor Profile Study: MP 0 to MP 196
Mobility Index
2014 and 2035 Data

2.5 Safety Performance Area

The Safety performance area consists of a primary measure (Safety Index) and four secondary measures, as illustrated in **Figure 13**. All measures relate to crashes that result in fatal and incapacitating injuries, as these types of crashes are the emphasis of the ADOT Strategic Highway Safety Plan (SHSP), FHWA, and MAP-21. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C.**

Figure 13: Safety Performance Measures



Primary Safety Index

The Safety Index is based on the bi-directional frequency and rate of fatal and incapacitating injury crashes, the relative cost of those types of crashes, and crash occurrences on similar roadways in Arizona. According to ADOT's 2010 Highway Safety Improvement Program Manual, fatal crashes have an estimated cost that is 14.5 times the estimated cost of incapacitating injury crashes ($5.8 million compared to $400,000).

Each corridor segment is rated on a scale by comparing the segment score with the average statewide score for similar operating environments. Because crash frequencies and rates vary depending on the operating environment of a particular roadway, statewide values were developed for similar operating environments defined by functional classification, urban vs. rural setting, number of travel lanes, and traffic volumes. For the I-40 West corridor, the following operating environments were identified:

- Urban 4-Lane Freeway: Segments 40W-3 and 14
- Rural 4-Lane Freeway with Daily Volume < 25,000: Segments 40W-1, 2, and 4 through 13

Secondary Safety Measures

Four secondary measures provide an in-depth evaluation of the different characteristics of safety performance:

Directional Safety Index

- This measure is based on the directional frequency and rate of fatal and incapacitating injury crashes

SHSP Emphasis Areas

ADOT's 2014 SHSP identified several emphasis areas for reducing fatal and incapacitating injury crashes. This measure compared rates of crashes in the top five SHSP emphasis areas to other corridors with a similar operating environment. The top five SHSP emphasis areas related to the following driver behaviors:

- Speeding and aggressive driving
- Impaired driving
- Lack of restraint usage
- Lack of motorcycle helmet usage
- Distracted driving

Crash Unit Types

- The percentage of total fatal and incapacitating injury crashes that involves crash unit types of motorcycles, trucks, or non-motorized travelers is compared to the statewide average on roads with similar operating environments

Safety Hot Spots

- The hot spot analysis identifies abnormally high concentrations of fatal and incapacitating injury crashes along the study corridor by direction of travel

For the Safety Index and the secondary safety measures, any segment that has too small of a sample size to generate statistically reliable performance ratings for a particular performance measure is considered to have "insufficient data" and is excluded from the safety performance evaluation for that particular performance measure.

Safety Performance Results

The Safety Index provides a high-level assessment of safety performance for the corridor and for each segment. The four secondary measures provide more detailed information to assess safety performance.

Based on the results of this analysis, the following observations were made:

- The crash unit type performance measures for crashes involving motorcycles and non-motorized travelers had insufficient data to generate reliable performance ratings for the I-40 West corridor
- Several segments had insufficient data to generate reliable performance ratings for crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas
- The weighted average of the Safety Index shows “average” performance for the I-40 West corridor; Segments 40W-1, 3, 4, 6, and 10 show “below average” performance for the Safety Index
- The Directional Safety Index results show similar findings to the Safety Index with Segments 40W-1, 3, 4, 6, 7, and 10 showing “below average” performance in at least one direction
- Segments 40W-5, 13, and 14 have insufficient data in the % of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors
- Segments 40W-1, 2, and 11 show “below average” performance in the % of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors
- Segments 40W-1, 2, 4, and 8 show “below average” performance for SHSP Crash Unit Types of trucks
- Safety hot spots include:
    - Segment 40W-3, EB/WB MP 48-51
    - Segment 40W-10, WB MP 157-158

Table 8 summarizes the Safety performance results for the I-40 West corridor. **Figure 14** illustrates the primary Safety Index performance and locations of Safety hot spots along the I-40 West corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 8: Safety Performance

Segment #	Segment Length (miles)	Total Fatal & Incapacitating Injury Crashes (F/I)	Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers
				EB	WB				
40W-1[b]	11	4 / 6	1.35	1.34	1.35	70%	Insufficient Data	Insufficient Data	Insufficient Data
40W-2[b]	32	8 / 29	1.00	1.19	0.81	65%	24%	Insufficient Data	Insufficient Data
40W-3[a]	12	7 / 12	1.26	1.47	1.06	37%	11%	Insufficient Data	Insufficient Data
40W-4[b]	19	10 / 15	1.75	1.46	2.04	32%	24%	Insufficient Data	Insufficient Data
40W-5[b]	6	1 / 3	0.67	0.08	1.26	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
40W-6[b]	18	7 / 15	1.59	1.36	1.81	45%	18%	Insufficient Data	Insufficient Data
40W-7[b]	10	3 / 7	1.20	1.52	0.88	20%	Insufficient Data	Insufficient Data	Insufficient Data
40W-8[b]	12	0 / 13	0.26	0.27	0.24	23%	15%	Insufficient Data	Insufficient Data
40W-9[b]	23	3 / 23	0.67	0.85	0.49	35%	12%	Insufficient Data	Insufficient Data
40W-10[b]	17	10 / 15	2.09	1.22	2.96	44%	20%	Insufficient Data	Insufficient Data
40W-11[b]	8	2 / 6	0.93	0.92	0.93	75%	Insufficient Data	Insufficient Data	Insufficient Data
40W-12[b]	16	1 / 11	0.33	0.13	0.54	25%	0%	Insufficient Data	Insufficient Data
40W-13[b]	6	1 / 3	0.55	0.91	0.19	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
40W-14[a]	6	1 / 3	0.32	0.60	0.04	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
Weighted Corridor Average			1.08	1.02	1.14	43%	17%	Insufficient Data	Insufficient Data
SCALES									
Performance Level	**Urban 4-Lane Freeway**								
Above Average	< 0.79					< 49%	< 7%	< 9%	< 5%
Average	0.79 - 1.21					49% - 59%	7% - 11%	9% - 12%	5% - 10%
Below Average	> 1.21					> 59%	> 11%	> 12%	> 10%
Performance Level	**Rural 4-Lane Freeway with Daily Volume <25,000**								
Above Average	< 0.73					< 43%	< 13%	< 5%	< 2%
Average	0.73 - 1.27					43% - 53%	13% - 17%	5% - 9%	2% - 3%
Below Average	> 1.27					> 53%	> 17%	> 9%	> 3%

[a] Urban 4-Lane Freeway
[b] Rural 4-Lane Freeway with Daily Volume <25,000
Note: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings.

Figure 14: Safety Performance

I-40 West Corridor Profile Study: MP 0 to MP 196
Safety Index and Hot Spots
2009 - 2013 Data

2.6 Freight Performance Area

The Freight performance area consists of a single primary measure (Freight Index) and five secondary measures, as illustrated in **Figure 15**. All measures related to the reliability of truck travel as measured by observed truck travel time speed and delays to truck travel from freeway closures or physical restrictions to truck travel. The detailed calculations and equations developed for each measure are available in **Appendix B** and the performance data for this corridor is contained in **Appendix C**.

Figure 15: Freight Performance Measures

Primary Freight Index

The Freight Index is a reliability performance measure based on the PTI for truck travel. The Truck Planning Time Index (TPTI) is the ratio of the 95th percentile truck travel time to the free-flow truck travel time. The TPTI reflects the extra buffer time needed for on-time delivery while accounting for non-recurring delay. Non-recurring delay refers to unexpected or abnormal delay due to closures or restrictions resulting from circumstances such as crashes, inclement weather, and construction activities.

Each corridor segment is rated on a scale with other segments in similar operating environments. Within the Freight performance area, the relevant operating environments are interrupted flow (e.g., signalized at-grade intersections are present) and uninterrupted flow (e.g., controlled access grade-separated conditions such as a freeway or interstate highway).

For the I-40 West corridor, the following operating environments were identified:

- Uninterrupted Flow: all segments

Secondary Freight Measures

The Freight performance area includes five secondary measures that provide an in-depth evaluation of the different characteristics of freight performance:

Recurring Delay (Directional Truck Travel Time Index [TTTI])

- The ratio of the average peak period truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TTTI recognizes the delay potential from recurring congestion during peak periods; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics

Non-Recurring Delay (Directional TPTI)

- The ratio of the 95th percentile truck travel time to the free-flow truck travel time (based on the posted speed limit up to a maximum of 65 miles per hour) in a given direction
- The TPTI recognizes the delay potential from non-recurring delays such as traffic crashes, weather, or other incidents; different thresholds are applied to uninterrupted flow (freeways) and interrupted flow (non-freeways) to account for flow characteristics
- The TPTI indicates the amount of time in addition to the typical travel time that should be allocated to make an on-time trip 95% of the time in a given direction

Closure Duration

- The average time (in minutes) a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel; a weighted average is applied to each closure that takes into account the distance over which the closure occurs

Bridge Vertical Clearance

- The minimum vertical clearance (in feet) over the travel lanes for underpass structures on each segment

Bridge Vertical Clearance Hot Spots

- A Bridge vertical clearance “hot spot” exists where the underpass vertical clearance over the mainline travel lanes is less than 16.25 feet and no exit/entrance ramps exist to allow vehicles to bypass the low clearance location
- If a location with a vertical clearance less than 16.25 feet can be avoided by using immediately adjacent exit/entrance ramps rather than the mainline, it is not considered a hot spot

Freight Performance Results

The Freight Index provides a high-level assessment of freight mobility for the corridor and for each segment. The five secondary measures provide more detailed information to assess freight performance.

Based on the results of this analysis, the following observations were made:

- The weighted average of the Freight Index shows "good" performance for the I-40 West corridor
- Segment 40W-10 shows "poor" performance for the Freight Index primary measure along with the EB TPTI secondary measure; all other segments and measurements for Freight Index, Directional TTTI, and Directional TPTI show either "good" or "fair" performance
- Closure Duration shows "poor" performance for Segments 40W-4 through 40W-14 in the EB direction, including the weighted corridor average, and for Segments 40W-10 through 40W-12 in the WB direction
- Bridge Vertical Clearance shows "fair" performance for most segments on the corridor, with the exception of Segments 40W-7, 8, and 13, which show "good" performance, and Segment 40W-5, which does not have any underpasses; most of the low-clearance structures on the corridor can be avoided by using the off/on ramps at the adjacent interchange
- No Bridge Vertical Clearance hot spots exist along the I-40 West corridor

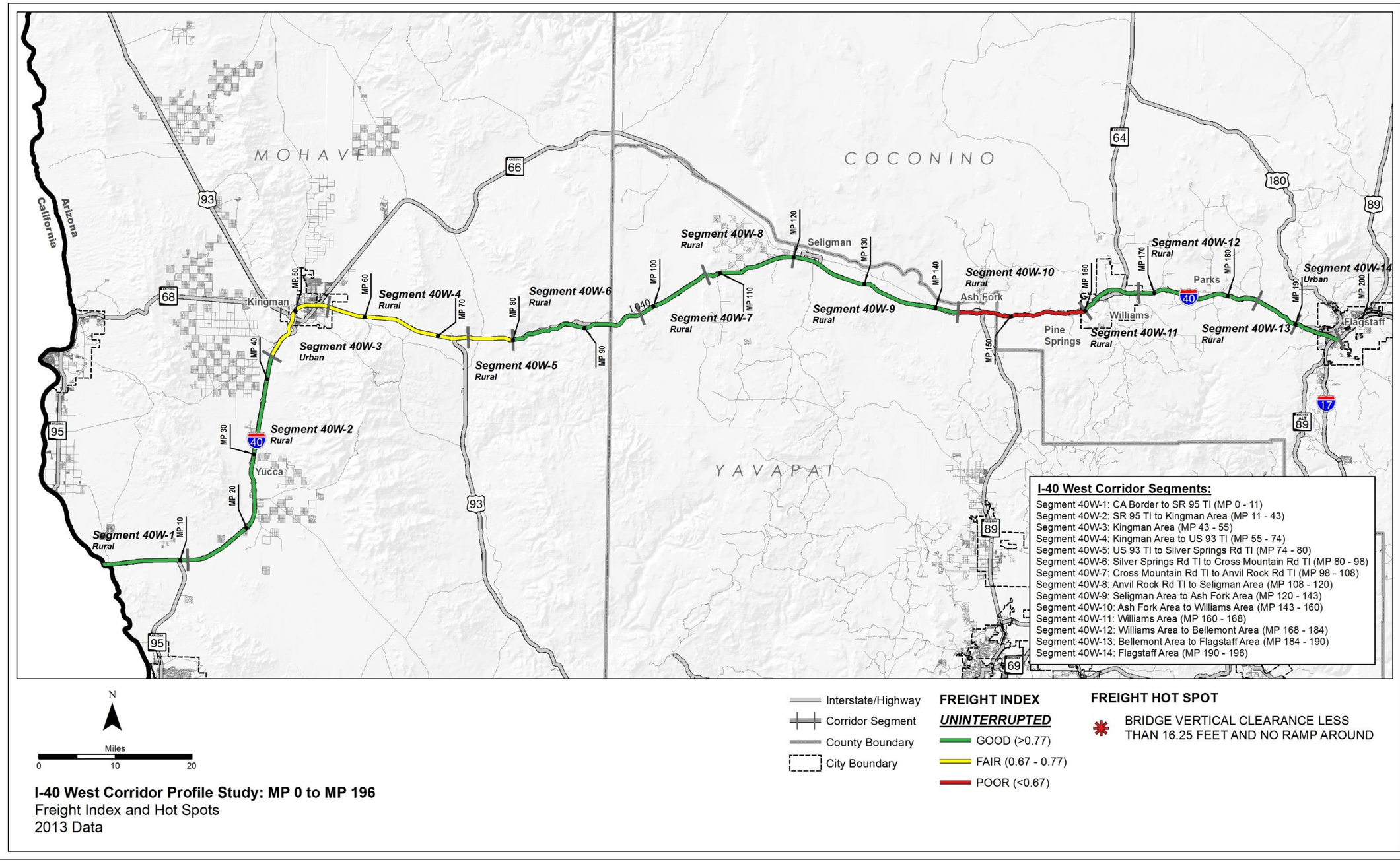
Table 9 summarizes the Freight performance results for the I-40 West corridor. **Figure 16** illustrates the primary Freight Index performance and locations of freight hot spots along the I-40 West corridor. Maps for each secondary measure can be found in **Appendix A**.

Table 9: Freight Performance

Segment #	Segment Length (miles)	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/ milepost/ year/mile)		Bridge Vertical Clearance (feet)
			EB	WB	EB	WB	EB	WB	
40W-1[2]	11	0.80	1.12	1.06	1.33	1.17	23.11	9.82	16.17
40W-2[2]	32	0.87	1.05	1.03	1.16	1.13	42.11	22.21	16.14
40W-3[1]	12	0.75	1.14	1.04	1.47	1.18	51.27	17.52	16.25
40W-4[2]	19	0.71	1.11	1.10	1.48	1.33	154.41	24.21	16.25
40W-5[2]	6	0.73	1.17	1.10	1.42	1.32	741.13	0.00	No UP
40W-6[2]	18	0.78	1.15	1.03	1.42	1.15	686.31	46.59	16.00
40W-7[2]	10	0.86	1.07	1.03	1.21	1.13	641.44	0.00	16.65
40W-8[2]	12	0.87	1.02	1.07	1.11	1.19	637.78	15.95	16.56
40W-9[2]	23	0.82	1.06	1.05	1.24	1.18	458.46	13.70	16.00
40W-10[2]	17	0.64	1.23	1.09	1.69	1.45	374.77	491.32	16.27
40W-11[2]	8	0.80	1.08	1.06	1.26	1.23	202.70	285.30	16.20
40W-12[2]	16	0.81	1.05	1.07	1.16	1.29	216.38	247.11	16.17
40W-13[2]	6	0.84	1.05	1.04	1.19	1.18	217.40	101.72	17.30
40W-14[1]	6	0.83	1.03	1.10	1.15	1.27	204.27	34.33	16.27
Weighted Corridor Average		0.80	1.09	1.06	1.31	1.22	308.92	93.06	16.22
SCALES									
Performance Level		**Uninterrupted**					**All**		
Good		> 0.77	< 1.15		< 1.30		< 44.18		> 16.5
Fair		0.67 - 0.77	1.15 -1.33		1.30 - 1.50		44.18 -124.86		16.0 - 16.5
Poor		< 0.67	> 1.33		> 1.50		> 124.86		< 16.0

[1]Urban Operating Environment
[2]Rural Operating Environment

Figure 16: Freight Performance



I-40 West Corridor Profile Study: MP 0 to MP 196
Freight Index and Hot Spots
2013 Data

2.7 Corridor Performance Summary

Based on the results of the performance evaluation, the following general observations were made related to the performance of the I-40 West corridor:

- Overall Performance: The Pavement, Mobility, and Freight performance areas show generally “good” performance; Bridge and Safety performance areas show generally “poor/below average” or “fair/average” performance
- Pavement Performance: The weighted average of the Pavement Index shows “good” performance for the I-40 West corridor; exceptions include Segments 40W-4 and 40W-13 which show “poor” performance for the Pavement Index; the weighted average of % Area Failure shows “poor” performance for the corridor; all segments except Segments 40W-3 and 40W-7 have Pavement hot spots
- Bridge Performance: The weighted average of the Bridge Index shows “fair” performance along the I-40 West corridor; the Bridge index predominantly shows “fair” performance, with the exception of Segments 40W-1 and 40W-7, which show “poor” and “good” performance, respectively, the weighted average for Lowest Bridge Rating shows “poor” performance for the corridor; all segments except Segments 40W-3, 4, 7, 11, and 13 have Bridge hot spots
- Mobility Performance: The weighted average of the Mobility Index shows “good” performance throughout the I-40 West corridor; the EB Closure Extent, EB Directional TTI, and EB/WB Directional PTI all show “fair” performance; the % Non-SOV Trips shows “poor” performance for the corridor along with many individual segments
- Safety Performance: The weighted average of the Safety Index shows “average” performance for the I-40 West corridor; performance measures for crashes involving motorcycles and non-motorized travelers had insufficient data to generate reliable performance ratings; several segments had insufficient data to generate reliable performance ratings for crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; the weighted averages show “average” performance for the Directional Safety Index and crashes involving trucks or behaviors associated with the SHSP Top 5 Emphasis Areas; Segments 40W-3 and 40W-10 have Safety hot spots
- Freight Performance: The weighted average of the Freight Index shows “good” performance along the I-40 West corridor; Closure Duration shows “poor” performance for Segments 40W-4 through 40W-14 in the EB direction, including the weighted corridor average, and for Segments 40W-10 through 40W-12 in the WB direction; no Freight hot spots exist along the corridor
- Lowest Performing Segments: Segments 40W-1, 40W-10, and 40W-11 have “poor/below average” performance for many performance measures
- Highest Performing Segments: Segments 40W-7, 40W-9, and 40W-14 have “good/above average” performance for many performance measures

Figure 17 shows the percentage of the I-40 West corridor that rates either “good/above average” performance, “fair/average” performance, or “poor/below average” performance for each primary measure. On the I-40 West corridor, Safety is the lowest performing area with 39% of the corridor in “poor” condition as it relates to the primary measure. Pavement, Mobility, and Freight are the highest performing areas along the I-40 West corridor with 51%, 100%, and 72% of the corridor, respectively, in “good” condition as it relates to the primary measures. The lowest performance along the I-40 West corridor generally occurs in the Bridge and Safety performance areas.

Table 10 shows a summary of corridor performance for all primary measures and secondary measure indicators for the I-40 West corridor. A weighted corridor average rating (based on the length of the segment) was calculated for each primary and secondary measure. The weighted average ratings are summarized in **Figure 18** which also provides a brief description of each performance measure. **Figure 18** represents the average for the entire corridor and any given segment or location could have a higher or lower rating than the corridor average.

Figure 17: Performance Summary by Primary Measure

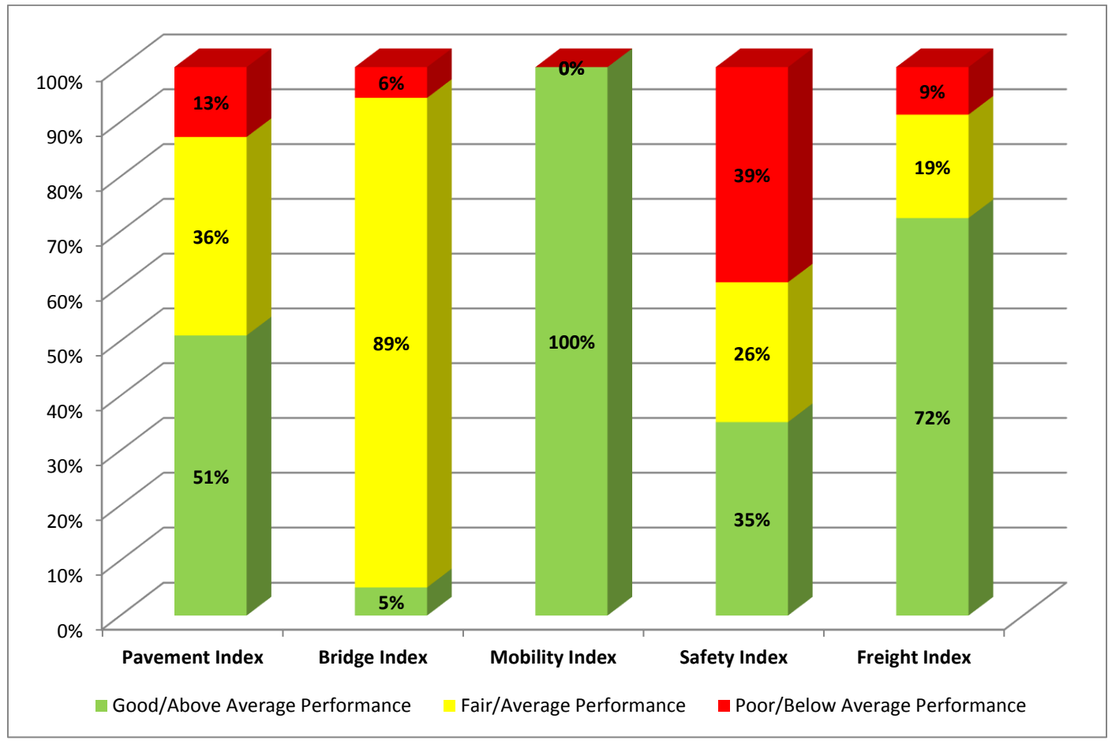


Figure 18: Corridor Performance Summary by Performance Measure

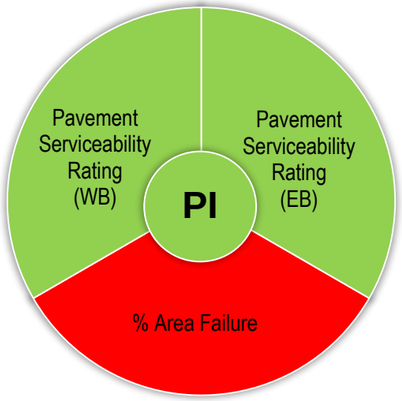
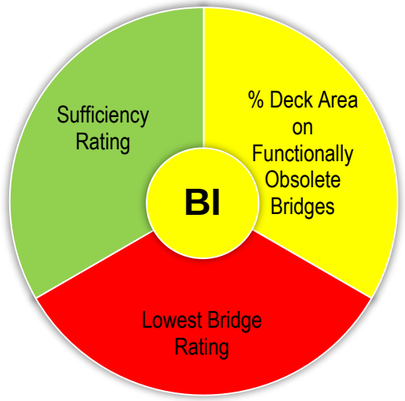
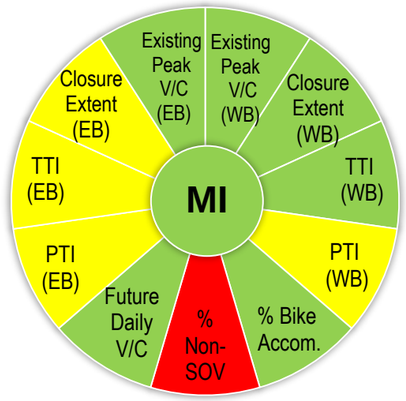
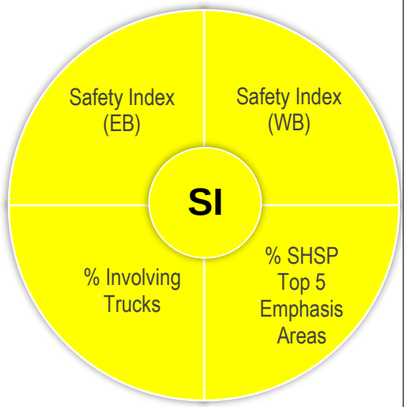
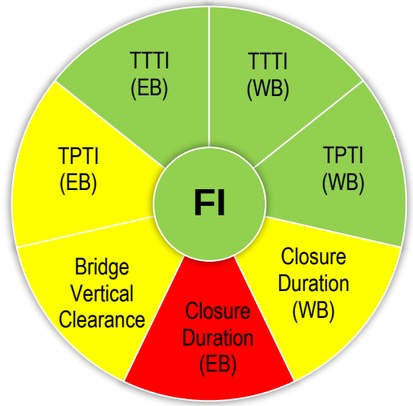
Pavement	Bridge	Mobility	Safety	Freight
				
Pavement Index (PI): based on two pavement condition ratings from the ADOT Pavement Database; the two ratings are the International Roughness Index (IRI) and the Cracking Rating	**Bridge Index (BI):** based on four bridge condition ratings from the ADOT Bridge Database; the four ratings are the Deck Rating, Substructure Rating, Superstructure Rating, and Structural Evaluation Rating	**Mobility Index (MI):** an average of the existing daily volume-to-capacity (V/C) ratio and the projected 2035 daily V/C ratio	**Safety Index (SI):** combines the bi-directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona	**Freight Index (FI):** a reliability performance measure based on the bi-directional planning time index for truck travel
➢ **Directional Pavement Serviceability Rating (PSR)** – the weighted average (based on number of lanes) of the PSR for the pavement in each direction of travel ➢ **% Area Failure** – the percentage of pavement area rated above failure thresholds for IRI or Cracking	➢ **Sufficiency Rating**– multipart rating includes structural adequacy and safety factors as well as functional aspects such as traffic volume and length of detour ➢ **% of Deck Area on Functionally Obsolete Bridges**– the percentage of deck area in a segment that is on functionally obsolete bridges; identifies bridges that no longer meet standards for current traffic volumes, lane width, shoulder width, or bridge rails; a bridge that is functionally obsolete may still be structurally sound ➢ **Lowest Bridge Rating** –the lowest rating of the four bridge condition ratings on each segment	➢ **Future Daily V/C** – the future 2035 V/C ratio provides a measure of future congestion if no capacity improvements are made to the corridor ➢ **Existing Peak Hour V/C** – the existing peak hour V/C ratio for each direction of travel provides a measure of existing peak hour congestion during typical weekdays ➢ **Closure Extent** – the average number of instances a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Directional Travel Time Index (TTI)** – the ratio of the average peak period travel time to the free-flow travel time; the TTI represents recurring delay along the corridor ➢ **Directional Planning Time Index (PTI)** – the ratio of the 95th percentile travel time to the free-flow travel time; the PTI represents non-recurring delay along the corridor ➢ **% Bicycle Accommodation** – the percentage of a segment that accommodates bicycle travel ➢ **% Non-single Occupancy Vehicle (Non-SOV) Trips** –the percentage of trips that are taken by vehicles carrying more than one occupant	➢ **Directional Safety Index** – the combination of the directional frequency and rate of fatal and incapacitating injury crashes, compared to crash occurrences on similar roadways in Arizona ➢ **% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors** – the percentage of fatal and incapacitating crashes that involve at least one of the five Strategic Highway Safety Plan (SHSP) emphasis areas on a given segment compared to the statewide average percentage on roads with similar operating environments ➢ **% of Fatal + Incapacitating Crashes Involving SHSP Crash Unit Types** – the percentage of total fatal and incapacitating injury crashes that involves a given crash unit type (motorcycle, truck, non-motorized traveler) compared to the statewide average percentage on roads with similar operating environments	➢ **Directional Truck Travel Time Index (TTTI)** – the ratio of the average peak period truck travel time to the free-flow truck travel time; the TTTI represents recurring delay along the corridor ➢ **Directional Truck Planning Time Index (TPTI)** – the ratio the 95th percentile truck travel time to the free-flow truck travel time; the TPTI represents non-recurring delay along the corridor ➢ **Closure Duration** – the average time a particular milepost is closed per year per mile on a given segment of the corridor in a specific direction of travel ➢ **Bridge Vertical Clearance** – the minimum vertical clearance over the travel lanes for underpass structures on each segment

Table 10: Corridor Performance Summary by Segment and Performance Measure

Segment #	Segment Length (miles)	Pavement Performance Area				Bridge Performance Area				Mobility Performance Area											
		Pavement Index	Directional PSR		% Area Failure	Bridge Index	Sufficiency Rating	% of Deck Area on Functionally Obsolete Bridges	Lowest Bridge Rating	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent (instances/ milepost/year/mile)		Directional TTI (all vehicles)		Directional PTI (all vehicles)		% Bicycle Accommodation	% Non-Single Occupancy Vehicle (SOV) Trips
			EB	WB								EB	WB	EB	WB	EB	WB	EB	WB		
40W-1[b2]	11	4.10	4.03	4.12	5%	3.66	81.10	5.7%	3	0.28	0.39	0.18	0.18	0.15	0.05	1.23	1.10	1.56	1.28	98%	9.8%
40W-2[b2]	32	4.38	4.29	4.21	2%	5.78	90.49	5.9%	4	0.29	0.40	0.19	0.19	0.16	0.09	1.12	1.09	1.29	1.22	50%	10.7%
40W-3[a1]	12	4.11	4.06	4.04	0%	5.80	95.02	19.1%	5	0.41	0.53	0.27	0.27	0.28	0.12	1.22	1.14	1.72	1.56	92%	19.0%
40W-4[b2]	19	3.20	3.10	3.48	48%	5.59	93.41	24.4%	5	0.19	0.16	0.19	0.19	0.37	0.17	1.16	1.15	1.69	1.54	100%	12.5%
40W-5[b2]	6	3.64	4.15	3.20	33%	5.13	94.85	21.0%	4	0.28	0.38	0.13	0.13	1.40	0.00	1.27	1.20	1.68	1.57	100%	6.2%
40W-6[b2]	18	3.20	3.41	3.22	54%	5.36	87.52	3.4%	4	0.25	0.34	0.13	0.12	1.20	0.12	1.24	1.10	1.64	1.27	100%	6.8%
40W-7[b2]	10	3.94	3.84	3.95	0%	6.72	95.52	0.0%	6	0.27	0.37	0.15	0.15	1.06	0.00	1.13	1.08	1.31	1.22	100%	6.8%
40W-8[b2]	12	4.09	4.02	3.98	8%	5.71	90.38	49.0%	4	0.29	0.40	0.16	0.15	1.07	0.12	1.09	1.14	1.23	1.37	100%	13.8%
40W-9[b2]	23	4.27	3.93	4.24	2%	5.21	87.19	0.0%	4	0.31	0.42	0.15	0.15	0.89	0.05	1.13	1.12	1.39	1.34	100%	10.8%
40W-10[b2]	17	3.64	3.50	3.55	48%	5.37	91.34	40.1%	4	0.31	0.43	0.13	0.13	0.71	0.59	1.31	1.16	1.98	1.65	100%	12.3%
40W-11[b2]	8	3.26	3.54	3.63	31%	5.81	95.07	23.5%	5	0.32	0.44	0.14	0.14	0.55	0.30	1.16	1.12	1.40	1.36	100%	8.1%
40W-12[b2]	16	3.60	3.76	3.94	9%	5.27	80.51	79.7%	5	0.30	0.38	0.14	0.14	0.45	0.25	1.11	1.13	1.28	1.46	98%	8.3%
40W-13[b2]	6	2.85	3.73	3.52	42%	5.50	97.11	0.0%	5	0.34	0.43	0.21	0.21	0.53	0.23	1.11	1.12	1.30	1.33	98%	12.4%
40W-14[a1]	6	3.73	3.87	3.73	28%	5.11	90.05	0.0%	4	0.51	0.67	0.27	0.27	0.53	0.13	1.04	1.14	1.20	1.36	99%	16.1%
Weighted Corridor Average		3.81	3.81	3.84	20%	5.53	91.23	17%	4.35	0.30	0.39	0.17	0.17	0.62	0.16	1.17	1.12	1.48	1.38	91%	10.9%

SCALES

Performance Level	Interstate			All				Urban and Fringe Urban	All	Uninterrupted		All	
Good/Above Average	> 3.75	> 3.75	< 5%	> 6.5	> 80	< 12%	> 6	< 0.71	< 0.22	< 1.15	< 1.3	> 90%	> 17%
Fair/Average	3.20 - 3.75	3.20 - 3.75	5% - 20%	5.0 - 6.5	50 - 80	12% - 40%	5 - 6	0.71 - 0.89	0.22 - 0.62	1.15 - 1.33	1.3 - 1.5	60% - 90%	11% - 17%
Poor/Below Average	< 3.20	< 3.20	> 20%	< 5.0	< 50	> 40%	< 5	> 0.89	> 0.62	> 1.33	> 1.5	< 60%	< 11%

Performance Level	Rural
Good/Above Average	< 0.56
Fair/Average	0.56 - 0.76
Poor/Below Average	> 0.76

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000

[1]Urban Operating Environment
[2]Rural Operating Environment

Table 10: Corridor Performance Summary by Segment and Performance Measure (continued)

Segment #	Segment Length (miles)	Safety Performance Area							Freight Performance Area							
		Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Areas Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers	Freight Index	Directional TTTI		Directional TPTI		Closure Duration (minutes/ milepost /year/ mile)		Bridge Vertical Clearance (feet)
			EB	WB						EB	WB	EB	WB	EB	WB	
40W-1[b2]	11	1.35	1.34	1.35	70%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.12	1.06	1.33	1.17	23.11	9.82	16.17
40W-2[b2]	32	1.00	1.19	0.81	65%	24%	Insufficient Data	Insufficient Data	0.87	1.05	1.03	1.16	1.13	42.11	22.21	16.14
40W-3[a1]	12	1.26	1.47	1.06	37%	11%	Insufficient Data	Insufficient Data	0.75	1.14	1.04	1.47	1.18	51.27	17.52	16.25
40W-4[b2]	19	1.75	1.46	2.04	32%	24%	Insufficient Data	Insufficient Data	0.71	1.11	1.10	1.48	1.33	154.41	24.21	16.25
40W-5[b2]	6	0.67	0.08	1.26	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.73	1.17	1.10	1.42	1.32	741.13	0.00	No UP
40W-6[b2]	18	1.59	1.36	1.81	45%	18%	Insufficient Data	Insufficient Data	0.78	1.15	1.03	1.42	1.15	686.31	46.59	16.00
40W-7[b2]	10	1.20	1.52	0.88	20%	Insufficient Data	Insufficient Data	Insufficient Data	0.86	1.07	1.03	1.21	1.13	641.44	0.00	16.65
40W-8[b2]	12	0.26	0.27	0.24	23%	15%	Insufficient Data	Insufficient Data	0.87	1.02	1.07	1.11	1.19	637.78	15.95	16.56
40W-9[b2]	23	0.67	0.85	0.49	35%	12%	Insufficient Data	Insufficient Data	0.82	1.06	1.05	1.24	1.18	458.46	13.70	16.00
40W-10[b2]	17	2.09	1.22	2.96	44%	20%	Insufficient Data	Insufficient Data	0.64	1.23	1.09	1.69	1.45	374.77	491.32	16.27
40W-11[b2]	8	0.93	0.92	0.93	75%	Insufficient Data	Insufficient Data	Insufficient Data	0.80	1.08	1.06	1.26	1.23	202.70	285.30	16.20
40W-12[b2]	16	0.33	0.13	0.54	25%	0%	Insufficient Data	Insufficient Data	0.81	1.05	1.07	1.16	1.29	216.38	247.11	16.17
40W-13[b2]	6	0.55	0.91	0.19	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.84	1.05	1.04	1.19	1.18	217.40	101.72	17.30
40W-14[a1]	6	0.32	0.60	0.04	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.83	1.03	1.10	1.15	1.27	204.27	34.33	16.27
Weighted Corridor Average		1.08	1.02	1.14	43.5%	16.6%	Insufficient Data	Insufficient Data	0.80	1.09	1.06	1.31	1.22	308.92	93.06	16.22

SCALES										
Performance Level	**Urban 4 Lane Freeway**					**Uninterrupted**			**All**	
Good/Above Average	< 0.79	< 49.1%	< 6.8%	< 9.3%	< 4.8%	> 0.77	< 1.15	< 1.3	< 44.18	> 16.5
Fair/Average	0.79 - 1.21	49.1% - 59.4%	6.8% - 10.9%	9.3% - 11.5%	4.8% - 10.3%	0.67 - 0.77	1.15 - 1.33	1.3 - 1.5	44.18 - 124.86	16.0 - 16.5
Poor/Below Average	> 1.21	> 59.4%	> 10.9%	> 11.5%	> 10.3%	< 0.67	> 1.33	> 1.5	> 124.86	< 16.0
Performance Level	**Rural 4 Lane Freeway with Daily Volume < 25,000**									
Good/Above Average	< 0.73	< 42.8%	< 13.2%	< 5%	< 1.7%					
Fair/Average	0.73 - 1.27	42.8% - 52.9%	13.2% - 17.0%	5% - 8.5%	1.7% - 2.5%					
Poor/Below Average	> 1.27	> 52.9%	> 17.0%	> 8.5%	> 2.5%					

[a]Urban 4 Lane Freeway
[b]Rural 4 Lane Freeway with Daily Volume < 25,000
[1]Urban Operating Environment
[2]Rural Operating Environment

Notes: "Insufficient Data" indicates there was not enough data available to generate reliable performance ratings
"No UP" indicates no underpasses are present in the segment

3.0 NEEDS ASSESSMENT

3.1 Corridor Objectives

Statewide goals and performance measures were established by the ADOT Long-Range Transportation Plan (LRTP), 2010-2035. Statewide performance goals that are relevant to I-40 West performance areas were identified and corridor goals were then formulated for each of the five performance areas that aligned with the overall statewide goals established by the LRTP. Based on stakeholder input, corridor goals, corridor objectives, and performance results, three “emphasis areas” were identified for the I-40 West corridor: Pavement, Bridge, and Safety.

Taking into account the corridor goals and identified emphasis areas, performance objectives were developed for each quantifiable performance measure that identify the desired level of performance based on the performance scale levels for the overall corridor and for each segment of the corridor. For the performance emphasis areas, the corridor-wide weighted average performance objectives are identified with a higher standard than for the other performance areas. **Table 11** shows the I-40 West corridor goals, corridor objectives, and performance objectives, and how they align with the statewide goals.

It is not reasonable within a financially constrained environment to expect that every performance measure will always be at the highest levels on every corridor segment. Therefore, individual corridor segment objectives have been set as “fair/average” or better and should not fall below that standard.

Achieving corridor and segment performance objectives will help ensure that investments are targeted toward improvements that support the safe and efficient movement of travelers on the corridor. Addressing current and future congestion, thereby improving mobility on congested segments, will also help the corridor fulfill its potential as a significant contributor to the region’s economy.

Corridor performance is measured against corridor and segment objectives to determine needs – the gap between observed performance and performance objectives.

Goal achievement will improve or reduce current and future congestion, increase travel time reliability, and reduce fatalities and incapacitating injuries resulting from vehicle crashes. Where performance is currently rated “good”, the goal is always to maintain that standard, regardless of whether or not the performance is in an emphasis area.

Table 11: Corridor Performance Goals and Objectives

ADOT Statewide LRTP Goals	I-40 West Corridor Goals	I-40 West Corridor Objectives	Performance Area	Primary Measure / Secondary Measure Indicators	Performance Objective: Corridor Average	Performance Objective: Segment
Improve Mobility and Accessibility **Support Economic Growth**	Improve mobility through additional capacity and improved roadway geometry Provide a safe and reliable route for recreational and tourist travel Provide safe, reliable and efficient connection to all communities along the corridor to permit efficient regional travel	Reduce current congestion and plan to facilitate future congestion that accounts for anticipated growth and land use changes Reduce delays from recurring and non-recurring events to improve reliability Improve bicycle and pedestrian accommodations	Mobility	Mobility Index	Fair or better	Fair or better
				Future Daily V/C		
				Existing Peak Hour V/C		
				Closure Extent		
				Directional Travel Time Index		
				Directional Planning Time Index		
				% Bicycle Accommodation		
				% Non-SOV Trips		
	Provide a safe, reliable and efficient freight route	Reduce delays and restrictions to freight movement to improve reliability Improve travel time reliability (including impacts to motorists due to freight traffic)	Freight	Freight Index	Fair or better	Fair or better
				Directional Truck Travel Time Index		
				Directional Truck Planning Time Index		
				Closure Duration		
				Bridge Vertical Clearance		
Preserve and Maintain the State Transportation System	Preserve and modernize highway infrastructure	Maintain structural integrity of bridges	Bridge (*Emphasis Area*)	Bridge Index	Good	Fair or better
				Sufficiency Rating		
				% of Deck Area on Functionally Obsolete Bridges		
				Lowest Bridge Rating		
		Improve pavement ride quality for all corridor users Reduce long-term pavement maintenance costs	Pavement (*Emphasis Area*)	Pavement Index	Good	Fair or better
				Directional Pavement Serviceability Rating		
				% Area Failure		
Enhance Safety and Security	Provide a safe, reliable, and efficient connection for the communities along the corridor Promote safety by implementing appropriate countermeasures	Reduce fatal and incapacitating injury crashes for all roadway users	Safety *(Emphasis Area)*	Safety Index	Above Average	Average or better
				Directional Safety Index		
				% of Crashes Involving SHSP Top 5 Emphasis Areas Behaviors		
				% of Crashes Involving Crash Unit Types		

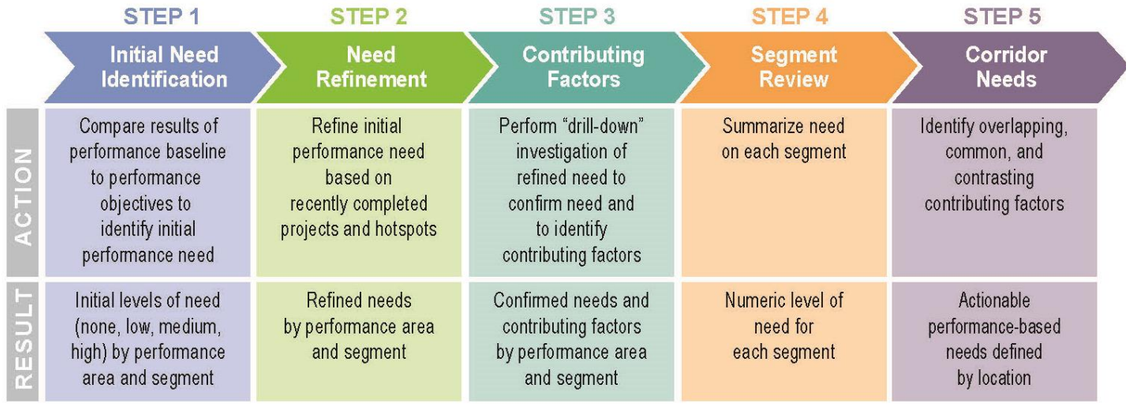
3.2 Needs Assessment Process

The following guiding principles were used as an initial step in developing a framework for the performance-based needs assessment process:

- Corridor needs are defined as the difference between the corridor performance and the performance objectives
- The needs assessment process should be systematic, progressive, and repeatable, but also allow for engineering judgment where needed
- The process should consider all primary and secondary performance measures developed for the study
- The process should develop multiple need levels including programmatic needs for the entire length of the corridor, performance area-specific needs, segment-specific needs, and location-specific needs (defined by MP limits)
- The process should produce actionable needs that can be addressed through strategic investments in corridor preservation, modernization, and expansion

The performance-based needs assessment process is illustrated in **Figure 19** and described in the following sections.

Figure 19: Needs Assessment Process



Step 1: Initial Needs Identification

The first step in the needs assessment process links baseline (existing) corridor performance with performance objectives. In this step, the baseline corridor performance is compared to the performance objectives to provide a starting point for the identification of performance needs. This mathematical comparison results in an initial need rating of None, Low, Medium, or High for each primary and secondary performance measure. An illustrative example of this process is shown below in **Figure 20**.

Figure 20: Initial Need Ratings in Relation to Baseline Performance (Bridge Example)

Performance Thresholds	Performance Level	Initial Level of Need	Description
6.5	Good	None*	All levels of Good and top 1/3 of Fair (>6.0)
	Good		
	Good		
	Fair		
	Fair	Low	Middle 1/3 of Fair (5.5-6.0)
5.0	Fair	Medium	Lower 1/3 of Fair and top 1/3 of Poor (4.5-5.5)
	Poor		
	Poor	High	Lower 2/3 of Poor (<4.5)
	Poor		

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

The initial level of need for each segment is refined to account for hot spots and recently completed or under construction projects, resulting in a final level of need for each segment. The final levels of need for each primary and secondary performance measure are combined to produce a weighted final need rating for each segment. Values of 0, 1, 2, and 3 are assigned to the initial need levels of None, Low, Medium, and High, respectively. A weight of 1.0 is applied to the Performance Index need and equal weights of 0.20 are applied to each need for each secondary performance measure. For directional secondary performance measures, each direction of travel receives a weight of 0.10.

Step 2: Need Refinement

In Step 2, the initial level of need for each segment is refined using the following information and engineering judgment:

- For segments with an initial need of None that contain hot spots, the level of need should be increased from None to Low
- For segments with an initial level of need where recently completed projects or projects under construction are anticipated to partially or fully address the identified need, the level of need should be reduced or eliminated as appropriate
- Programmed projects that are expected to partially or fully address an identified need are not justification to lower the initial need because the programmed projects may not be

implemented as planned; in addition, further investigations may suggest that changes in the scope of a programmed project may be warranted

The resulting final needs are carried forward for further evaluation in Step 3.

Step 3: Contributing Factors
In Step 3, a more detailed review of the condition and performance data available from ADOT is conducted to identify contributing factors to the need. Typically, the same databases used to develop the baseline performance serve as the principal sources for the more detailed analysis. However, other supplemental databases may also be useful sources of information. The databases used for diagnostic analysis are listed below:

Pavement Performance Area

- Pavement Rating Database

Bridge Performance Area

- ABISS

Mobility Performance Area

- Highway Performance Monitoring System (HPMS) Database
- AZTDM
- Real-time traffic conditions data produced by American Digital Cartography Inc. (HERE) Database
- Highway Conditions Reporting System (HCRS) Database

Safety Performance Area

- Crash Database

Freight Performance Area

- HERE Database
- HCRS Database

In addition, other sources considered helpful in identifying contributing factors are:

- Maintenance history (from ADOT PeCoS database for pavement), the level of past investments, or trends in historical data that provide context for pavement and bridge history
- Field observations from ADOT district personnel can be used to provide additional information regarding a need that has been identified
- Previous studies can provide additional information regarding a need that has been identified

Step 3 results in the identification of performance-based needs and contributing factors by segment (and MP locations, if appropriate) that can be addressed through investments in preservation, modernization, and expansion projects to improve corridor performance. See **Appendix D** for more information.

Step 4: Segment Review
In this step, the needs identified in Step 2 and refined in Step 3 are quantified for each segment to numerically estimate the level of need for each segment. Values of 0 to 3 are assigned to the final need levels (from Step 3) of None, Low, Medium, and High, respectively. A weighting factor is applied to the performance areas identified as emphasis areas and a weighted average need is calculated for each segment. The resulting average need score can be used to compare levels of need between segments within a corridor and between segments in different corridors.

Step 5: Corridor Needs
In this step, the needs and contributing factors for each performance area are reviewed on a segment-by-segment basis to identify actionable needs and to facilitate the formation of solution sets that address multiple performance areas and contributing factors. The intent of this process is to identify overlapping, common, and contrasting needs to help develop strategic solutions. This step results in the identification of corridor needs by specific location.

3.3 Corridor Needs Assessment

This section documents the results of the needs assessment process described in the prior section. The needs in each performance area were classified as either None, Low, Medium, or High based on how well each segment performed in the existing performance analysis. The needs for each segment were numerically combined to estimate the average level of need for each segment of the corridor

The final needs assessments for each performance measure, along with the scales used in analysis, are shown in **Table 12** through **Table 16**.

Pavement Needs Refinement and Contributing Factors

- The level of need in Segments 40W-1, 2, 8, 9, and 12 was increased from None to Low due to the presence of hot spots
- The level of need in Segment 40W-4 was reduced from High to None due to recently completed projects
- The level of need in Segment 40W-6 was reduced from High to Low due to recently completed projects
- The level of need in Segments 40W-5 and 40W-10 was reduced from Low to None due to recently completed projects
- See **Appendix D** for detailed information on contributing factors

Table 12: Final Pavement Needs

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Pavement Index	Directional PSR		% Area Failure				
		EB	WB					
40W-1	4.10	4.03	4.12	4.5%	0.0	1 mile EB (MP 3-4)	None	Low
40W-2	4.38	4.29	4.21	1.6%	0.0	1 mile WB (MP 41-42)	None	Low
40W-3	4.11	4.06	4.04	0.0%	0.0	None	Repaving done in 2015 WB at MP 43	None
40W-4	3.20	3.10	3.48	47.5%	2.9	14 miles EB (MP 57-71), 5 miles WB (MP 63-67, 73-74)	Repaving done in 2014 EB/WB at MP 57-71.5 and in 2015-2016 EB/WB at MP 72-74 addresses need	None
40W-5	3.64	4.15	3.20	33.3%	0.8	4 miles WB (MP 75-79)	Repaving done in 2015-2016 EB/WB at MP 74-79 addresses need	None
40W-6	3.20	3.41	3.22	54.1%	2.9	8 miles EB (MP 83-90, 92-93), 11 miles WB (MP 82-84, 85-87, 88-90, 92-97)	Repaving done in 2015-2016 EB/WB at MP 82-98 partially addresses need	Low
40W-7	3.94	3.84	3.95	0.0%	0.0	None	Repaving done in 2015-2016 EB/WB at MP 98-108 addresses need	None
40W-8	4.09	4.02	3.98	8.3%	0.0	1 mile EB (MP 112-113), 1 mile WB (MP 113-114)	None	Low
40W-9	4.27	3.93	4.24	2.2%	0.0	1 mile EB (MP 123-124)	None	Low
40W-10	3.64	3.50	3.55	47.9%	0.8	9 miles EB (MP 150-155, 156-160), 7 miles WB (MP 152-159	Repaving done in 2013 EB/WB at MP 146-160 addresses need	None
40W-11	3.26	3.54	3.63	31.3%	2.7	4 miles EB (MP 160-161, 164-166, 167-168),1 mile WB (MP 167-168)	None	High
40W-12	3.60	3.76	3.94	9.4%	0.0	1 miles EB (MP 178-179), 2 miles WB (MP 171-172, 178-179)	None	Low
40W-13	2.85	3.73	3.52	41.7%	3.7	3 miles EB (MP 186-189), 2 miles WB (MP 187-189)	None	High
40W-14	3.73	3.87	3.73	28.0%	0.6	1 mile EB (MP 190-191), 2 miles WB (MP 190-191, 195-196)	None	Low

Level of Need (Score)	Performance Score Need Scale		Segment Level Need Scale
None* (0)	> 3.57	< 10%	0
Low (1)	3.38 - 3.57	10% - 15%	< 1.5
Medium (2)	3.02 - 3.38	15% - 25%	1.5 - 2.5
High (3)	< 3.02	> 25%	> 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Bridge Needs Refinement and Contributing Factors

- Segments 40W-1, 2, 5, 6, 8, 9, 10, 12, and 14 contain Bridge hot spots
- The level of need for Segment 40W-6 was reduced from Medium to Low due to recently completed projects
- The level of need for Segment 40W-10 was reduced from High to Low due to recently completed projects
- See **Appendix D** for detailed information on contributing factors

Table 13: Final Bridge Needs

Segment #	Performance Score and Level of Need				Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Bridge Index	Sufficiency Rating	% of Deck on Functionally Obsolete Bridges	Lowest Bridge Rating				
40W-1	3.66	81.1	5.7%	3	3.6	Colorado River Br MP 0.01 (#957)	None	High
40W-2	5.78	90.5	5.9%	4	1.4	Boulder Wash Br EB/WB MP 11.12 (#1587 & #1588), Chemehuevi Wash Br EB/WB MP 11.46 (#1589 & #376), Franconia Wash Br EB/WB MP 13.61 (#377 & #1591), Illavar Wash Br EB MP 18.30 (#1310), Flat Top Wash Br WB MP 21.01 (#1312), MacKenzie Wash Br EB/WB MP 23.56 (#1315 & #365), Rock Creek Bridge EB/WB MP 27.85 (#366 & #901), Griffith Wash Br WB MP 40.42 (#1658)	None	Low
40W-3	5.80	95.0	19.1%	5	1.2	None	None	Low
40W-4	5.59	93.4	24.4%	5	1.3	None	None	Low
40W-5	5.13	94.9	21.0%	4	2.5	Big Sandy Wash Br WB MP 75.40 (#1253)	None	High
40W-6	5.36	87.5	3.4%	4	2.4	Willow Creek Br #2 EB MP 83.30 (#1593), Willow Ranch Rd TI UP MP 87.57 (#1770)	Willow Creek Br #2 EB - extension of retaining walls, repair of girders, new deck overlay in June 2015, Maintenance on Willow Creek Bridges (MP 83-86); Bridge repairs completed in 2015 as part of a large pavement rehabilitation project at MP 86-98	Low
40W-7	6.72	95.5	0.0%	6	0.0	None	Bridge repairs completed in 2015 as part of a large pavement rehabilitation project at MP 98-108	None
40W-8	5.71	90.4	49.0%	4	1.7	Anvil Rock Rd TI UP MP 109.65 (#1610)	None	Medium
40W-9	5.21	87.2	0.0%	4	2.4	W Seligman TI UP MP 121.07 (#1258), E Seligman TI OP WB/EB MP 123.32 (#1260 & #1259), Pineveta Draw Br EB/WB MP 138.47 (#1175 & #1176)	None	Medium
40W-10	5.37	91.3	40.1%	4	2.6	Ashfork Draw Br EB/WB MP 146.15 (#1764 & #1765), Johnson Canyon Br EB/WB MP 148.91 (#808 & #441)	Rehabilitation of ten EB/WB bridge decks near the West Ash Fork Traffic Interchange completed in 2015 at MP 144-147	Low
40W-11	5.81	95.1	23.5%	5	1.3	None	None	Low
40W-12	5.27	80.5	79.7%	5	2.5	Pittman Road TI UP MP 171.70 (#740)	None	High
40W-13	5.50	97.1	0.0%	5	2.2	None	None	Medium
40W-14	5.11	90.0	0.0%	4	2.4	A1 Mountain TI UP MP 190.54 (#896), W Flagstaff TI OP EB MP 191.69 (#1128)	None	Medium

Level of Need (Score)	Performance Score Need Scale				Segment Level Need Scale
None (0)	> 6.0	> 70	< 21.0%	> 5.0	0
Low (1)	5.5 - 6.0	60 - 70	21.0% - 31.0%	5.0	< 1.5
Medium (2)	4.5 - 5.5	40 - 60	31.0% - 49.0%	4.0	1.5 - 2.5
High (3)	< 4.5	< 40	> 49.0%	< 4.0	> 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Mobility Needs Refinement and Contributing Factors

- There were no recently completed mobility projects along the corridor
- See **Appendix D** for detailed information on contributing factors

Table 14: Final Mobility Needs

Segment #	Performance Score and Level of Need										Initial Segment Need	Recently Completed Projects	Final Segment Need
	Mobility Index	Future Daily V/C	Existing Peak Hour V/C		Closure Extent		Directional TTI		Directional PTI		% Bicycle Accommodation			
			EB	WB	EB	WB	EB	WB	EB	WB				
40W-1	0.28	0.39	0.18	0.18	0.15	0.05	1.23	1.10	1.56	1.28	98%	0.3	None	Low
40W-2	0.29	0.40	0.19	0.19	0.16	0.09	1.12	1.09	1.29	1.22	50%	0.6	None	Low
40W-3	0.41	0.53	0.27	0.27	0.28	0.12	1.22	1.14	1.72	1.56	92%	0.6	New DMS at MP 45 (EB)	Low
40W-4	0.19	0.16	0.19	0.19	0.37	0.17	1.16	1.15	1.69	1.54	100%	0.6	None	Low
40W-5	0.28	0.38	0.13	0.13	1.40	0.00	1.27	1.20	1.68	1.57	100%	1.0	None	Low
40W-6	0.25	0.34	0.13	0.12	1.20	0.12	1.24	1.10	1.64	1.27	100%	0.7	None	Low
40W-7	0.27	0.37	0.15	0.15	1.06	0.00	1.13	1.08	1.31	1.22	100%	0.3	None	Low
40W-8	0.29	0.40	0.16	0.15	1.07	0.12	1.09	1.14	1.23	1.37	100%	0.4	None	Low
40W-9	0.31	0.42	0.15	0.15	0.89	0.05	1.13	1.12	1.39	1.34	100%	0.4	None	Low
40W-10	0.31	0.43	0.13	0.13	0.71	0.59	1.31	1.16	1.98	1.65	100%	1.2	New DMS at MP 148 (WB)	Low
40W-11	0.32	0.44	0.14	0.14	0.55	0.30	1.16	1.12	1.40	1.36	100%	0.3	None	Low
40W-12	0.30	0.38	0.14	0.14	0.45	0.25	1.11	1.13	1.28	1.46	98%	0.3	None	Low
40W-13	0.34	0.43	0.21	0.21	0.53	0.23	1.11	1.12	1.30	1.33	98%	0.2	None	Low
40W-14	0.51	0.67	0.27	0.27	0.53	0.13	1.04	1.14	1.20	1.36	99%	0.2	New DMS at MP 198 (WB)	Low

Level of Need (Score)	Performance Score Need Scale					Segment Level Need Scale
None* (0)	≤ 0.77 (Urban) ≤ 0.63 (Rural)	< 0.35	< 1.21	< 1.37	> 80%	0
Low (1)	0.77 - 0.83 (Urban) 0.63 - 0.69 (Rural)	0.35 - 0.49	1.21 - 1.27	1.37 - 1.43	70% - 80%	< 1.5
Medium (2)	0.83 - 0.95 (Urban) 0.69 - 0.83 (Rural)	0.49 - 0.75	1.27 - 1.39	1.43 - 1.57	50% - 70%	1.5 - 2.5
High (3)	≥ 0.95 (Urban) ≥ 0.83 (Rural)	> 0.75	> 1.39	> 1.57	< 50%	> 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Safety Needs Refinements and Contributing Factors

- Safety hot spots are present in Segments 40W-3 and 40W-10, which already have High levels of need
- See **Appendix D** for detailed information on contributing factors

Table 15: Final Safety Needs

Segment #	Performance Score and Level of Need							Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Safety Index	Directional Safety Index		% of Fatal + Incapacitating Injury Crashes Involving SHSP Top 5 Emphasis Area Behaviors	% of Fatal + Incapacitating Injury Crashes Involving Trucks	% of Fatal + Incapacitating Injury Crashes Involving Motorcycles	% of Fatal + Incapacitating Injury Crashes Involving Non-Motorized Travelers				
		EB	WB								
40W-1[b]	1.35	1.34	1.35	70%	Insufficient Data	Insufficient Data	Insufficient Data	3.0	None	None	High
40W-2[b]	1.00	1.19	0.81	65%	24%	Insufficient Data	Insufficient Data	2.4	None	None	Medium
40W-3[a]	1.26	1.47	1.06	37%	11%	Insufficient Data	Insufficient Data	2.8	EB/WB crash concentration MP 48-51	None	High
40W-4[b]	1.75	1.46	2.04	32%	24%	Insufficient Data	Insufficient Data	4.2	None	None	High
40W-5[b]	0.67	0.08	1.26	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.2	None	None	Low
40W-6[b]	1.59	1.36	1.81	45%	18%	Insufficient Data	Insufficient Data	4.1	None	Repaving done in 2015-2016 EB/WB at MP 86-98 included guard rail and rumble strip installation and bridge repairs	High
40W-7[b]	1.20	1.52	0.88	20%	Insufficient Data	Insufficient Data	Insufficient Data	2.3	None	Repaving done in 2015-2016 EB/WB at MP 98-108 included guard rail and rumble strip installation and bridge repairs	Medium
40W-8[b]	0.26	0.27	0.24	23%	15%	Insufficient Data	Insufficient Data	0.4	None	None	Low
40W-9[b]	0.67	0.85	0.49	35%	12%	Insufficient Data	Insufficient Data	0.0	None	None	None
40W-10[b]	2.09	1.22	2.96	44%	20%	Insufficient Data	Insufficient Data	4.1	WB crash concentration MP 157-158	None	High
40W-11[b]	0.93	0.92	0.93	75%	Insufficient Data	Insufficient Data	Insufficient Data	1.8	None	None	Medium
40W-12[b]	0.33	0.13	0.54	25%	0%	Insufficient Data	Insufficient Data	0.0	None	None	None
40W-13[b]	0.55	0.91	0.19	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	None	None
40W-14[a]	0.32	0.60	0.04	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data	0.0	None	None	None

Level of Need (Score)		Performance Score Needs Scale					Segment Level Need Scale
None* (0)	a b	≤ 0.93 ≤ 0.91	≤ 52% ≤ 46%	≤ 8% ≤ 14%	≤ 10% ≤ 6%	≤ 7% ≤ 2%	0
Low (1)	a b	0.93 - 1.07 0.91 - 1.09	52% - 55% 46% - 49%	8% - 9% 14% - 15%	10% - 11% 6% - 7%	7% - 9% 2% - 2%	≤ 1.5
Medium (2)	a b	1.07 – 1.35 1.09 - 1.45	55% - 62% 49% - 56%	9% - 12% 15% - 18%	11% - 13% 7% - 9%	9% - 12% 2% - 3%	1.5 - 2.5
High (3)	a b	≥ 1.35 ≥ 1.45	≥ 62% ≥ 56%	≥ 12% ≥ 18%	≥ 13% ≥ 9%	≥ 12% ≥ 3%	≥ 2.5

a: Urban 4-Lane Freeway
b: Rural 4-Lane Freeway with Daily Volume < 25,000

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Freight Needs Refinements and Contributing Factors

- There are no bridge vertical clearance hot spots on the corridor
- See **Appendix D** for detailed information on contributing factors

Table 16: Final Freight Needs

Segment	Performance Score and Level of Need								Initial Segment Need	Hot Spots	Recently Completed Projects	Final Segment Need
	Freight Index	Directional TTTI		Directional TPTI		Closure Duration		Bridge Vertical Clearance				
		NB	SB	NB	SB	NB	SB					
40W-1	0.80	1.12	1.06	1.33	1.17	23.11	9.82	16.17	0.2	None	None	Low
40W-2	0.87	1.05	1.03	1.16	1.13	42.11	22.21	16.14	0.4	None	None	Low
40W-3	0.75	1.14	1.04	1.47	1.18	51.27	17.52	16.25	0.4	None	New DMS at MP 45 (EB)	Low
40W-4	0.71	1.11	1.10	1.48	1.33	154.41	24.21	16.25	1.7	None	None	Medium
40W-5	0.73	1.17	1.10	1.42	1.32	741.13	0.00	No UP	1.4	None	None	Low
40W-6	0.78	1.15	1.03	1.42	1.15	686.31	46.59	16.00	0.8	None	None	Low
40W-7	0.86	1.07	1.03	1.21	1.13	641.44	0.00	16.65	0.3	None	None	Low
40W-8	0.87	1.02	1.07	1.11	1.19	637.78	15.95	16.56	0.3	None	None	Low
40W-9	0.82	1.06	1.05	1.24	1.18	458.46	13.70	16.00	0.7	None	None	Low
40W-10	0.64	1.23	1.09	1.69	1.45	374.77	491.32	16.27	4.4	None	New DMS at MP 148 (WB)	High
40W-11	0.80	1.08	1.06	1.26	1.23	202.70	285.30	16.20	0.8	None	None	Low
40W-12	0.81	1.05	1.07	1.16	1.29	216.38	247.11	16.17	0.8	None	None	Low
40W-13	0.84	1.05	1.04	1.19	1.18	217.40	101.72	17.30	0.5	None	None	Low
40W-14	0.83	1.03	1.10	1.15	1.27	204.27	34.33	16.27	0.5	None	New DMS at MP 198 (WB)	Low

Level of Need (Score)	Performance Score Need Scale					Segment Level Need Scale
None* (0)	≥ 0.74	≤ 1.21	≤ 1.37	≤ 71.07	≥ 16.33	0
Low (1)	0.70 - 0.74	1.21 - 1.27	1.37 - 1.43	71.07 - 97.97	16.17 - 16.33	≤ 1.5
Medium (2)	0.64 - 0.70	1.27 - 1.39	1.43 - 1.57	97.97 - 151.75	15.83 - 16.17	1.5 - 2.5
High (3)	≤ 0.64	≥ 1.39	≥ 1.57	≥ 151.75	≤ 15.83	≥ 2.5

**A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study.*

Segment Review

The needs for each segment were combined to numerically estimate the average level of need for each segment of the corridor. **Table 17** provides a summary of needs for each segment across all performance areas, with the average need score for each segment presented in the last row of the table. A weighting factor of 1.5 is applied to the need scores of the performance areas identified as emphasis areas (Pavement, Bridge, and Safety for the I-40 West corridor). There are no segments with a High average need, eleven segments with a Medium average need, and three segments with a Low average need.

Table 17: Summary of Needs by Segment

Performance Area	Segment Number and Mileposts (MP)													
	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement+	Low	Low	None	None	None	Low	None	Low	Low	None	High	Low	High	Low
Bridge+	High	Low	Low	Low	High	Low	None	Medium	Medium	Low	Low	High	Medium	Medium
Mobility	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Safety+	High	Medium	High	High	Low	High	Medium	Low	None	High	Medium	None	None	None
Freight	Low	Low	Low	Medium	Low	Low	Low	Low	Low	High	Low	Low	Low	Low
Average Need	**1.92**	**1.23**	**1.23**	**1.38**	**1.23**	**1.46**	**0.77**	**1.23**	**1.00**	**1.54**	**1.69**	**1.23**	**1.46**	**1.00**

Average Need Scale	
None*	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

+ Identified as an emphasis area for the I-40 West corridor

** A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study*

Summary of Corridor

The needs in each performance area are shown in **Figure 21** and summarized below:

Pavement Needs

- Overall Pavement needs are Low or None throughout the corridor except for Segment 40W-11 and Segment 40W-13, which have High levels of need; both segments with High levels of need will be addressed by programmed improvement projects
- Twelve segments contain Pavement hot spots, but all of these except for three segments (40W-1, 40W-2, and 40W-14) have been addressed by recently completed projects, will be addressed by programmed improvement projects, or are segments that have not experienced high levels of historical investment
- Through a field review, a review of previously completed geotechnical reports, and discussions with ADOT District staff, it has been determined that there are likely sub-surface issues at the hot spots in Segment 40W-1 at milepost (MP) 3-4 and in Segment 40W-14 at MP 195-196, and that the limits of the hot spots should be expanded to MP 3-8 in Segment 40W-1 and to MP 191-196 in Segment 40W-14 to address the historical Pavement needs in the area

Bridge Needs

- Overall Bridge needs are High for Segments 40W-1, 5, and 12 and Medium for Segments 40W-8, 9, 13, and 14
- Sixty-six of the 149 bridges on the corridor exhibit needs in the Bridge performance area; approximately 50% of the bridges with needs have programmed improvement projects
- Ten bridges are both hot spots and bridges identified in the historical review; these bridges are in Segments 40W-1, 2, 8, 10, and 14

Mobility Needs

- Overall Mobility needs are Low throughout the corridor; there are no programmed projects to address identified Mobility needs
- Mobility needs are primarily related to an above average frequency of full freeway closures, likely due to weather and incidents, or related to a below average planning time index (PTI), likely due to grades, congestion, incidents, and weather

Safety Needs

- Overall Safety needs are High for Segments 40W-1, 4, 6, and 10 and Medium for Segments 40W-2, 3, 7, and 11; there are no programmed projects that are anticipated to fully address identified Safety needs
- Safety hot spots are in Segment 40W-3 at MP 48-51 EB/WB and in Segment 40W-10 at MP 157-158 WB
- Crashes involving single vehicles travelling at speeds too fast for conditions, overturned vehicles, fixed objects, and/or roadway departures exceed the statewide average crashes for similar operating environments on the majority of the I-40 West corridor
- Truck-involved crashes comprise over 24 percent of total crashes between MP 11-43 in Segment 40W-2; crashes in this segment typically involve distracted or inattentive drivers, road departures, fixed object, and overturning

Freight Needs

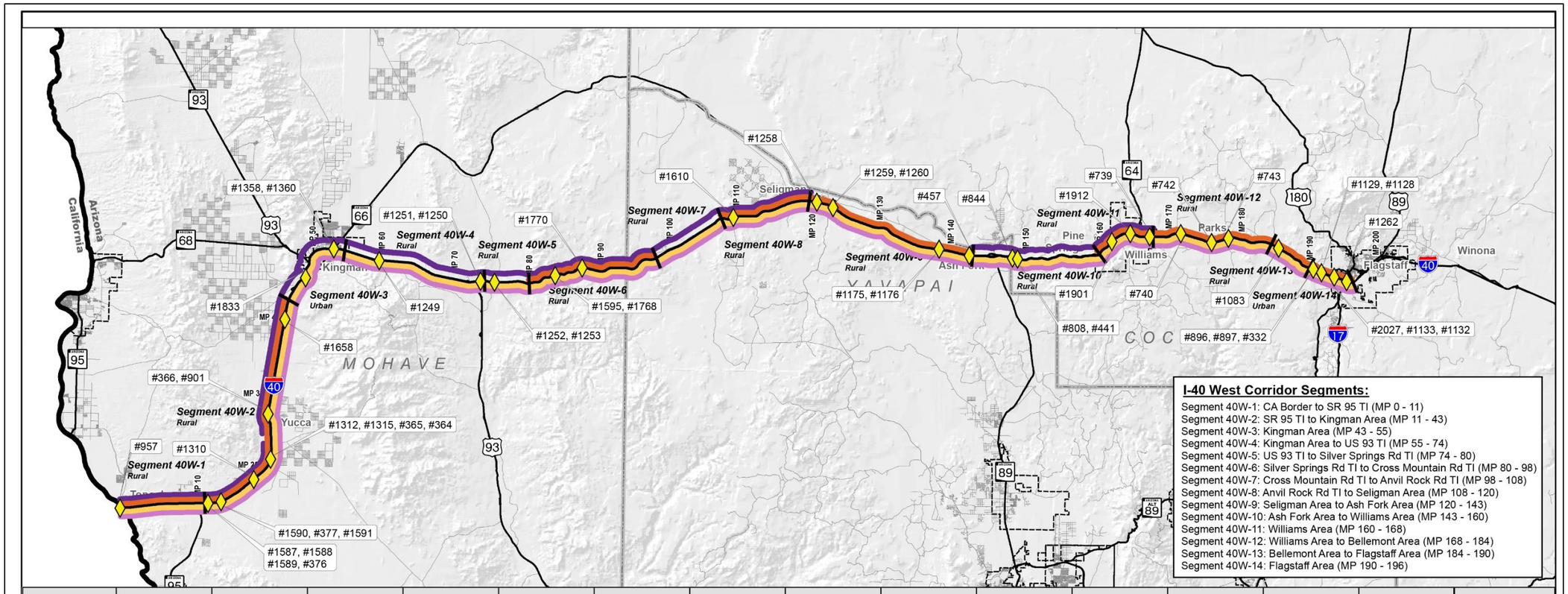
- Overall Freight needs are Low throughout the corridor except for Segment 40W-4, which has a Medium need, and Segment 40W-10, which has a High need; there are no programmed projects to address identified Freight needs
- Freight needs are primarily related to an above average duration of full freeway closures, likely due to weather and incidents, or related to a below average truck PTI, likely due to grades, congestion, incidents, and weather
- There are no Freight hot spots on the I-40 West corridor

Overlapping Needs

This section identifies overlapping performance needs on the I-40 West corridor, which provides guidance to develop strategic solutions that address more than one performance area with elevated levels of need. Completing projects that address multiple needs presents the opportunity to more effectively improve overall performance. A summary of the overlapping needs that relate to locations with elevated levels of need is provided below:

- A majority of the segments on the I-40 West corridor shows some level of need in four out of the five performance areas
- Segment 40W-1 and Segment 40W-10 have High levels of need in two performance areas: Safety and Freight
- Segments 40W-4, 11, and 13 have a High level of need in one performance area and a Medium level of need in another performance area

Figure 21: Corridor Needs Summary



Performance Area	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14	Performance Area
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196	
Pavement*	Low	Low	None	None	None	Low	None	Low	Low	None	High	Low	High	Low	Pavement*
Bridge*	High	Low	Low	Low	High	Low	None	Medium	Medium	Low	Low	High	Medium	Medium	Bridge*
Mobility	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Mobility
Safety*	High	Medium	High	High	Low	High	Medium	Low	None	High	Medium	None	None	None	Safety*
Freight	Low	Low	Low	Medium	Low	Low	Low	Low	Low	High	Low	Low	Low	Low	Freight
Average Need	1.92	1.23	1.23	1.38	1.23	1.46	0.77	1.23	1.00	1.54	1.69	1.23	1.46	1.00	Average Need

** Identified as emphasis area for I-40 West corridor*
\+ A segment need rating of 'None' does not indicate a lack of needed improvements; rather, it indicates that the segment performance score exceeds the established performance thresholds and strategic solutions for that segment will not be developed as part of this study

I-40 West Corridor Profile Study: MP 0 to MP 196
Needs Summary

N
Miles
0 10 20

Interstate/Highway
Corridor Segment
County Boundary
City Boundary
#1234 ADOT Structure Number

Performance Area Needs
Pavement
Mobility
Safety
Freight
Bridge

Level of Need	Average Need
None+	< 0.1
Low	0.1 - 1.0
Medium	1.0 - 2.0
High	> 2.0

4.0 STRATEGIC SOLUTIONS

The principal objective of the CPS is to identify strategic solutions (investments) that are performance-based to ensure that available funding resources are used to maximize the performance of the State's key transportation corridors. One of the first steps in the development of strategic solutions is to identify areas of elevated levels of need (i.e., Medium or High). Addressing areas of Medium or High need will have the greatest effect on corridor performance and are the focus of the strategic solutions. Segments with Medium or High needs and specific locations of hot spots are considered strategic investment areas for which strategic solutions should be developed. Segments with lower levels of need or without identified hot spots are not considered candidates for strategic investment and are expected to be addressed through other ADOT programming processes. The I-40 West strategic investment areas (resulting from the elevated needs) are shown in **Figure 22**.

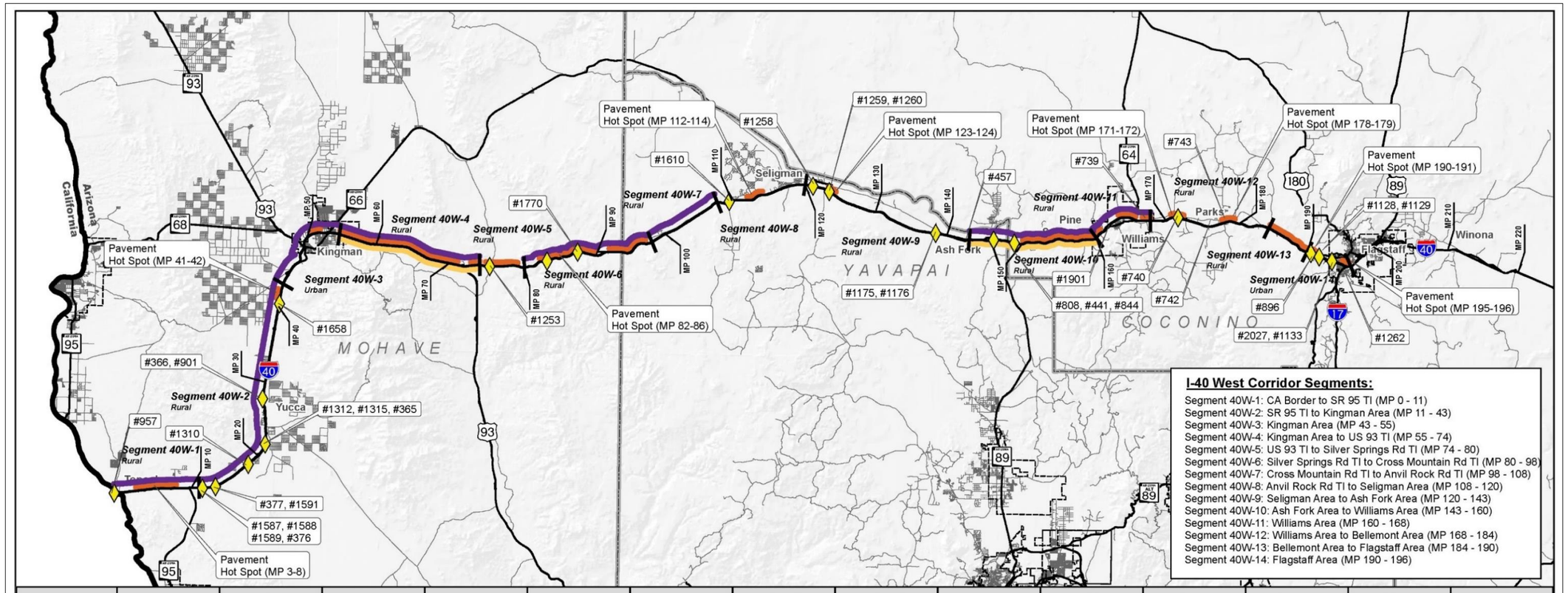
4.1 Screening Process

This section examines qualifying strategic needs and determines if the needs in those locations require action. In some cases, needs that are identified do not advance to solutions development and are screened out from further consideration because they have been or will be addressed through other measures, including:

- A project is programmed to address this need
- The need is a result of a Pavement or Bridge hot spot that does not show historical investment or rating issues; these hot spots will likely be addressed through other ADOT programming means
- A bridge is not a hot spot but is located within a segment with a Medium or High level of need; this bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes
- The need is determined to be non-actionable (i.e., cannot be addressed through an ADOT project)
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need

Table 18 notes if each potential strategic need advanced to solution development, and if not, the reason for screening the potential strategic need out of the process. Locations advancing to solutions development are marked with Yes (Y); locations not advancing are marked with No (N) and highlighted. This screening table provides specific information about the needs in each segment that will be considered for strategic investment. The table identifies the level of need – either Medium or High segment needs, or segments without Medium or High level of need that have a hot spot. Each area of need is assigned a location number in the screening table to help document and track locations considered for strategic investment.

Figure 22: Strategic Investment Areas



Performance Area	40W-1	40W-2	40W-3	40W-4	40W-5	40W-6	40W-7	40W-8	40W-9	40W-10	40W-11	40W-12	40W-13	40W-14
	MP 0-11	MP 11-43	MP 43-55	MP 55-74	MP 74-80	MP 80-98	MP 98-108	MP 108-120	MP 120-143	MP 143-160	MP 160-168	MP 168-184	MP 184-190	MP 190-196
Pavement*	Hotspot	Hotspot	-	-	-	Hotspot	-	Hotspot	Hotspot	-	High	Hotspot	High	Hotspot
Bridge*	High	Hotspot	-	-	High	Hotspot	-	Medium	Medium	Hotspot		High	Medium	Medium
Mobility	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Safety*	High	Medium	High	High	-	High	Medium	-	-	High	Medium	-	-	-
Freight	-	-	-	Medium	-	-	-	-	-	High	-	-	-	-

** Identified as emphasis area for I-40 West corridor*

Note: Figure shows strategic investment areas which are segments with Medium and High levels of need and locations of hot spots. A "-" symbol indicates a segment level of need of Low or None, which is not considered strategic."

I-40 West Corridor Profile Study: MP 0 to MP 196
Strategic Investment Areas

N
Miles
0 10 20

Interstate/Highway
Corridor Segment
County Boundary
City Boundary
#1234 ADOT Structure Number

Performance Area Needs
Pavement
Mobility
Safety
Freight
Bridge

Level of Need
Low
Medium
High

Table 18: Strategic Investment Area Screening

Segment # and MP	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
40W-1 (MP 0-11)	Hot Spot	High		High		L1	Pavement	Failure hot spot at MP 3-8 with subgrade issues causing heaving and large cracks; high historical investment	Y	No programmed project to address Pavement need; high historical investment
						L2	Bridge	Colorado River Bridge #957 at MP 0 has deck rating of 3; identified in historical review; Caltrans responsibility with ADOT as financial partner	Y	Caltrans has already begun scoping process for improvements and coordination with ADOT to address need
						L3	Safety	MP 0-11 has above average vehicle-vehicle and run-off road crashes; likely contributing factors include road departure, inattention/distraction, fatigue, pavement surface condition, shoulder/rumble strip condition, lack of restraint usage, and improper lane changes	Y	No programmed project to address Safety need; crash types align with ADOT Strategic Highway Safety Plan (SHSP) behavior emphasis areas
40W-2 (MP 11-43)	Hot Spot	Hot Spot		Medium		L4	Pavement	Failure hot spot WB at MP 41-42; high historical investment	Y	No programmed project to address Pavement need; high historical investment
						L5	Bridge	Boulder Wash EB #1587 at MP 11 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; Programmed project in FY 2016 expected to address deck need; superstructure need will likely be addressed by current ADOT processes
						L6	Bridge	Boulder Wash WB #1588 at MP 11 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L7	Bridge	Chemehuevi Wash EB #1589 at MP 12 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L8	Bridge	Chemehuevi Wash WB #376 at MP 12 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L9	Bridge	Franconia Wash EB #1591 at MP 13 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L10	Bridge	Franconia Wash WB #377 at MP 13 has deck and superstructure ratings of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L11	Bridge	Illavar Wash EB #1310 at MP 18 has deck and superstructure ratings of 4; identified in historical review	Y	Programmed project in FY 2016 expected to address deck need but no programmed project to address superstructure; identified in historical review
						L12	Bridge	Flat Top Wash WB #1312 at MP 21 has deck and superstructure ratings of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L13	Bridge	MacKensie Wash EB #1315 at MP 24 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L14	Bridge	MacKensie Wash WB #365 at MP 24 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L15	Bridge	Rock Creek EB #366 at MP 28 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L16	Bridge	Rock Creek WB #901 at MP 28 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L17	Bridge	Griffith Wash Br WB #1658 at MP 40 has deck and superstructure ratings of 4; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L18	Safety	MP 11-43 has above average truck-related, single vehicle, and roadside object-related crashes; likely contributing factors include road departure, inattention/distraction, fatigue, pavement surface condition, shoulder/rumble strip condition, clear zone slopes, obstructions, and driving under the influence	Y	No programmed project to address Safety need; crash types align with ADOT SHSP behavior and unit type emphasis areas
40W-3 (MP 43-55)				High		L19	Safety	MP 43-55 has above average rear end, head-on, and overturning crashes; likely contributing factors include median crossing, roadway departure, speeding, improper lane changes, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, urban operating conditions, driving under the influence, and lack of restraint usage	Y	No programmed project to address Safety need; crash hot spot exists EB/WB at MP 48-51
40W-4 (MP 55-74)				High	Medium	L21	Safety	MP 55-74 has above average rear end crashes; likely contributing factors include speeding, improper lane changes, high traffic volume operating conditions, and driving under the influence	Y	No programmed project to address Safety need; crashes expected to increase as congestion increases in the future if improvements are not made
						L22	Freight	MP 55-74 has moderate non-recurring congestion, particularly in the EB direction, likely due to peak seasonal volumes, terrain, and closures due to incidents and weather events	Y	No programmed project to address Freight need; congestion expected to worsen without improvements

Legend: Strategic investment area screened out from further consideration

Table 18: Strategic Investment Area Screening (continued)

Segment # and MP	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
40W-5 (MP 74-80)		High				L23	Bridge	Big Sandy Wash WB #1253 at MP 75 has deck rating of 4; identified in historical review	N	Programmed project in FY 2018 expected to address need
						L24	Bridge	Big Sandy Wash EB #1252 at MP 75 has deck rating of 5; identified in historical review	N	Programmed project in FY 2018 expected to address need
40W-6 (MP 80-98)	Hot Spot	Hot Spot		High		L25	Pavement	Failure hot spot at MP 82-86 with possible subgrade issues causing potholes; low historical investment	N	Programmed project in FY 2019 expected to address need; no high historical investment
						L26	Bridge	Willow Ranch Rd TI UP #1770 at MP 88 has superstructure rating of 4; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L27	Safety	MP 80-98 has above average single vehicle, overturning, truck-related, and night-time crashes; likely contributing factors include speeding, inattention/distraction, road departure, pavement surface condition, traffic control device reflectivity, shoulder/rumble strip condition, clear zone slopes and obstructions, lack of restraint usage, and slippery/wet pavement	Y	Programmed rockfall mitigation project in FY 2017 may help address crashes related to clear zone obstructions; no programmed project to address remaining Safety need
40W-7 (MP 98-108)				Medium		L28	Safety	MP 98-108 has above average single vehicle, overturning, and night-time crashes; likely contributing factors include speeding, road departure, traffic control device reflectivity, shoulder/rumble strip condition, clear zone slopes and obstructions, and slippery/wet pavement	Y	No programmed project to address Safety need
40W-8 (MP 108-120)	Hot Spot	Medium				L29	Pavement	Failure hot spot at MP 112-113 EB and MP 113-114 WB with possible subgrade issues causing potholes; low historical investment	N	Programmed project in FY 2019 expected to address need; no high historical investment
						L30	Bridge	Anvil Rock Rd TI UP #1610 at MP 109 has deck rating of 4 and superstructure rating of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
40W-9 (MP 120-143)	Hot Spot	Medium				L32	Pavement	Failure hot spot at MP 123-124 EB with possible subgrade issues causing large cracks; low historical investment	N	No high historical investment; no programmed project to address need at MP 123-124 but will likely be addressed by current ADOT processes; ADOT could potentially expand project limits of programmed project in FY 2019 at MP 108-123 to include MP 123-124 to address need
						L33	Bridge	W Seligman TI UP #1258 at MP 121 has deck rating of 4; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L34	Bridge	E Seligman TI WB #1260 at MP 123 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L35	Bridge	E Seligman TI EB #1259 at MP 123 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L36	Bridge	Pineveta Draw EB #1175 at MP 139 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L37	Bridge	Pineveta Draw WB #1176 at MP 139 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L38	Bridge	Partridge Creek WB #457 at MP 143 has superstructure rating of 5; identified in historical review	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
40W-10 (MP 143-160)		Hot Spot		High	High	L39	Bridge	Johnson Canyon EB #808 at MP 149 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L40	Bridge	Johnson Canyon WB #441 at MP 149 has deck and superstructure ratings of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L41	Safety	MP 143-160 has above average single vehicle and weather-related crashes; likely contributing factors include speeding, road departure, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, and slippery/wet pavement	Y	No programmed project to address Safety need; crash hot spot exists WB at MP 157-158
						L31	Freight	MP 143-160 has high recurring and non-recurring congestion, particularly in the EB direction, likely due to terrain and closures due to incidents and weather events	Y	No programmed project to address Freight need; congestion expected to continue without improvements

Legend: Strategic investment area screened out from further consideration

Table 18: Strategic Investment Area Screening (continued)

Segment # and MP	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
40W-11 (MP 160-168)	High			Medium		L42	Pavement	MP 160-168 has failure hot spots at MP 160-161, MP 164-166, and MP 167-168 with possible subgrade issues causing potholes; medium historical investment	N	Programmed project in FY 2018 (MP 162-179) expected to address need within those project limits; no high historical investment; no programmed project to address pavement need at MP 160-161 but will likely be addressed by current ADOT processes; ADOT could potentially expand programmed project limits to include MP 160-161 to address need
						L43	Safety	MP 160-168 has above average single vehicle, overturning, and weather-related crashes; likely contributing factors include speeding, inattention/distraction, fatigue, road departure, pavement surface condition, shoulder/rumble strip condition, clear zone slopes and obstructions, lack of restraint usage, and slippery/wet pavement	Y	No programmed project to address Safety need; crash types align with ADOT SHSP behavior emphasis areas
40W-12 (MP 168-184)	Hot Spot	High				L44	Pavement	Failure hot spots at MP 171-172 and MP 178-179 with possible subgrade issues causing potholes; high historical investment	N	Programmed project in FY 2018 expected to address Pavement need
						L45	Bridge	Pittman Road TI #740 at MP 172 has deck and superstructure ratings of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L46	Bridge	Spitz Springs Rd #742 at MP 176 has superstructure rating of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L47	Bridge	Parks Road TI #743 at MP 178 has deck rating of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
40W-13 (MP 184-190)	High	Medium				L48	Pavement	MP 184-190 has failure hot spots at MP 186-189 with possible shoulder condition issues causing potholes, potentially due to lack of shoulder milling; medium historical investment	N	Programmed project in FY 2019 expected to address Pavement need
						L58	Bridge	Bellemont TI UP WB #1083 at MP 185 has structural evaluation rating of 5; identified in historical review	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
						L59	Bridge	Bellemont TI UP EB #783 at MP 185 has no ratings below a 6; identified in historical review	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
40W-14 (MP 190-196)	Hot Spot	Medium				L49	Pavement	Failure hot spots at MP 191-196 with possible subgrade issues causing potholes; high historical investment	Y	Programmed project in FY 2019 expected to address need at MP 190-191; high historical investment; no programmed project to address pavement need at MP 191-196
						L50	Bridge	A-1 Mountain TI #896 at MP 191 has deck rating of 4; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L51	Bridge	Riordan ATSFRR OP #897 at MP 191 has structural evaluation rating of 5; not identified in historical review	N	Not identified in historical review; will likely be addressed by current ADOT processes
						L52	Bridge	W Flagstaff TI WB #1129 at MP 192 has deck and superstructure ratings of 5; not identified in historical review	N	Programmed project in FY 2019 expected to address deck need but no programmed project to address superstructure; not identified in historical review; will likely be addressed by current ADOT processes
						L53	Bridge	W Flagstaff TI EB #1128 at MP 192 has deck and superstructure ratings of 5; identified in historical review	Y	Programmed project in FY 2019 expected to address deck need but no programmed project to address superstructure; identified in historical review
						L54	Bridge	Flag Ranch TI EB #2027 at MP 193 has deck and superstructure ratings of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L55	Bridge	Woody Mountain Road EB #1132 at MP 194 has superstructure rating of 5; identified in historical review	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; will likely be addressed by current ADOT processes
						L56	Bridge	Woody Mountain Road WB #1133 at MP 194 has deck and superstructure ratings of 5; identified in historical review	Y	No programmed project to address Bridge need; identified in historical review
						L57	Bridge	SR 89A WB #1262 at MP 195 has superstructure rating of 5; not identified in historical review	N	Bridge does not have a rating of 4 or multiple ratings of 5 so it is not a hot spot; not identified in historical review; will likely be addressed by current ADOT processes

Legend: Strategic investment area screened out from further consideration

4.2 Candidate Solutions

For each elevated need within a strategic investment area that is not screened out, a candidate solution is developed to address the identified need. Each candidate solution is assigned to one of the following three P2P investment categories based on the scope of the solution:

- Preservation
- Modernization
- Expansion

Documented performance needs serve as the foundation for developing candidate solutions for corridor preservation, modernization, and expansion. Candidate solutions are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process.

Characteristics of Strategic Solutions

Candidate solutions should include some or all of the following characteristics:

- Do not recreate or replace results from normal programming processes
- May include programs or initiatives, areas for further study, and infrastructure projects
- Address elevated levels of need (High or Medium) and hot spots
- Focus on investments in modernization projects (to optimize current infrastructure)
- Address overlapping needs
- Reduce costly repetitive maintenance
- Extend operational life of system and delay expansion
- Leverage programmed projects that can be expanded to address other strategic elements
- Provide measurable benefit

Candidate Solutions

A set of 25 candidate solutions are proposed to address the identified needs on the I-40 West corridor.

Table 19 identifies each strategic location that has been assigned a candidate solution with a number (e.g., CS40W.1, CS40W.2, etc.). Each candidate solution is comprised of one or more components to address the identified needs. The assigned candidate solution numbers are linked to the location number and provide tracking capability through the rest of the process. The locations of proposed solutions are shown on the map in **Figure 23**.

Candidate solutions developed to address an elevated need in the Pavement or Bridge performance area will include two options: rehabilitation or full replacement. These solutions are initially evaluated through a Life-Cycle Cost Analysis (LCCA) to provide insights into the cost-effectiveness of these options so a recommended approach can be identified. Candidate solutions developed to address an elevated need in the Mobility, Safety, or Freight performance areas are advanced directly to the Performance Effectiveness Evaluation. In some cases, there may be multiple solutions identified to address the same area of need.

Candidate solutions that are recommended to expand or modify the scope of an already programmed project are noted and are not advanced to solution evaluation and prioritization. These solutions are directly recommended for programming.

Table 19: Candidate Solutions

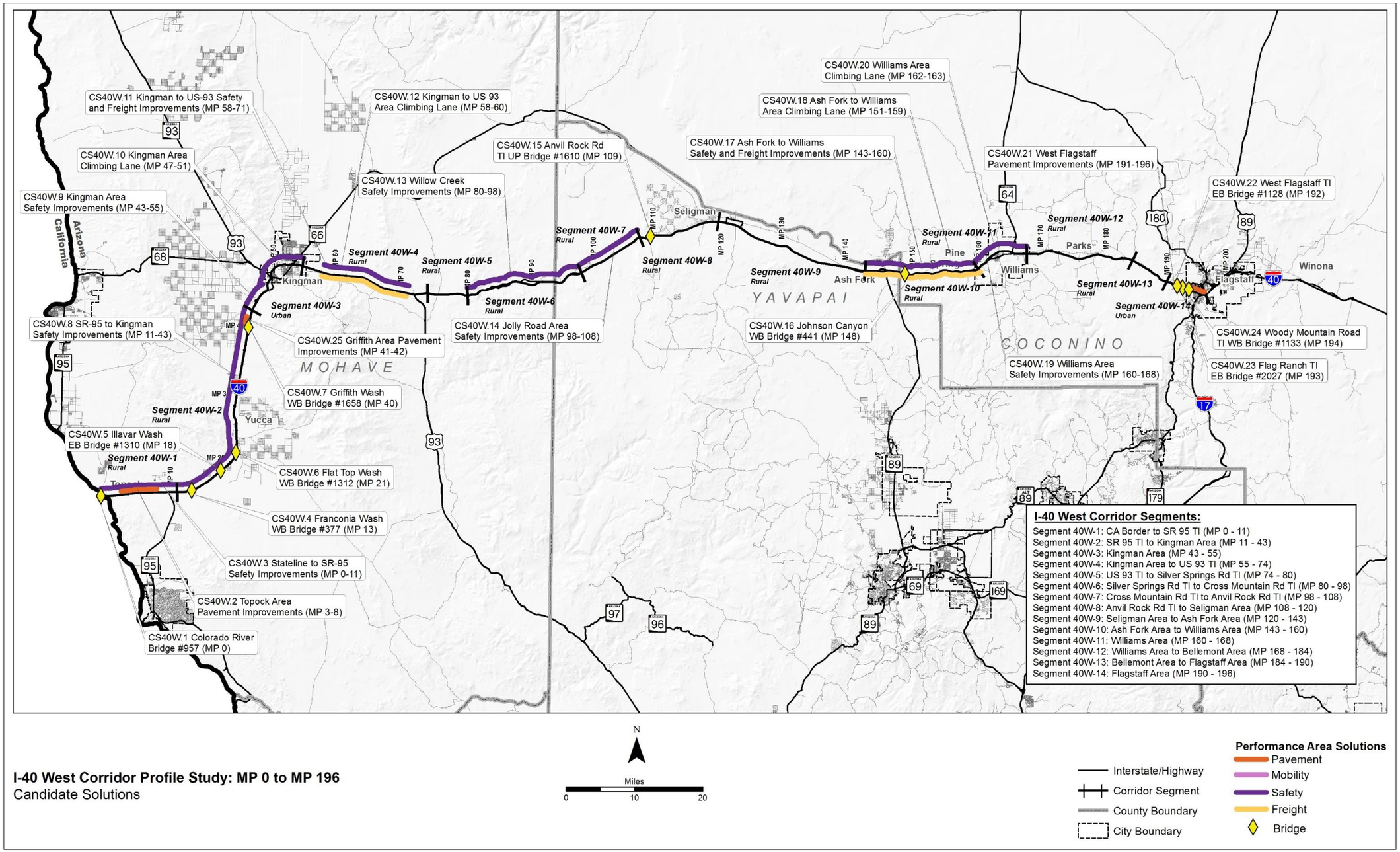
Candidate Solution #	Segment #	Location #	Beginning Milepost	Ending Milepost	Candidate Solution Name	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS40W.1	40W-1	L2	0	0	Colorado River Bridge #957	-	-Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement; Cost reflects ADOT's anticipated share of costs	M
CS40W.2	40W-1	L1	3	8	Topock Area Pavement Improvements	A	-Rehabilitate pavement	P
						B	-Replace pavement	M
CS40W.3	40W-1	L3	0	11	Stateline to SR 95 Safety Improvements	-	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips)	M
CS40W.4	40W-2	L10	13	13	Franconia Wash WB Bridge #377	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.5	40W-2	L11	18	18	Illavar Wash EB Bridge #1310	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.6	40W-2	L12	21	21	Flat Top Wash WB Bridge #1312	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.7	40W-2	L17	40	40	Griffith Wash WB Bridge #1658	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.8	40W-2	L18	11	43	SR 95 to Kingman Safety Improvements	-	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips -Provide signs for driver information (advance notice of rest area)	M
CS40W.9	40W-3	L19	43	55	Kingman Area Safety Improvements	-	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Install median cable barrier at MP 47-51 -Implement Variable Speed Limits (VSL) at EB/WB MP 47-53 and integrate with existing DMS at EB MP 45 and WB MP 55	M
CS40W.10	40W-3	L19	47	51	Kingman Area Climbing Lane	-	-Construct EB climbing lane MP 47-51 -Widen W Kingman TI OP EB bridge #1835, MP 48.84 -Widen Clack Canyon Wash EB bridge #1837, MP 49.70 -Widen White Cliff Road OP EB bridge #1839, MP 50.09	M
CS40W.11	40W-4	L21/L22	58	71	Kingman to US 93 Safety and Freight Improvements	-	-Implement VSL at EB/WB MP 58-71 and integrate with existing DMS at EB MP 69 and with new DMS at EB MP 55 and WB MP 72	M
CS40W.12	40W-4	L22	58	60	Kingman to US 93 Area Climbing Lane	-	-Construct EB climbing lane at MP 58-60	M
CS40W.13	40W-6	L27	80	98	Willow Creek Safety Improvements	-	-Construct EB climbing lane at MP 80-83 and MP 93-97 -Widen Echeverria OP EB bridge #1675, MP 94.45 -Widen Cross Mountain TI OP EB bridge #1677, MP 96.02 -Implement VSL at EB MP 80-83, EB MP 88-90, and EB MP 93-97 and integrate with existing RWIS at MP 91 and new DMS at EB MP 79 and WB MP 98	M

Table 19: Candidate Solutions (continued)

Candidate Solution #	Segment #	Location #	Beginning Milepost	Ending Milepost	Candidate Solution Name	Option*	Scope	Investment Category (Preservation [P], Modernization [M], Expansion [E])
CS40W.14	40W-7	L28	98	108	Jolly Road Area Safety Improvements	-	-Rehabilitate shoulder (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 101-104 and integrate with new RWIS at MP 103 and new DMS at EB MP 100 and WB MP 105	M
CS40W.15	40W-8	L30	109	109	Anvil Rock Rd TI UP Bridge #1610	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.16	40W-10	L40	148	148	Johnson Canyon WB Bridge #441	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.17	40W-10	L31/L41	143	160	Ash Fork to Williams Safety and Freight Improvements	-	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 151-159 and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at EB MP 144 and with new DMS at WB MP 160	M
CS40W.18	40W-10	L31	151	159	Ash Fork to Williams Area Climbing Lane	-	-Construct EB climbing lane at MP 151-152 and MP 156-159 -Widen Devil Dog TI OP EB bridge #1178, MP 157.71	M
CS40W.19	40W-11	L43	160	168	Williams Area Safety Improvements	-	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 161-163 and integrate with existing RWIS at MP 159 and existing DMS at WB MP 168 and with new DMS at EB MP 160	M
CS40W.20	40W-11	L43	162	163	Williams Area Climbing Lane	-	-Construct WB climbing lane at MP 162-163 -Widen SFRR and Cata Lake OP WB bridge #1902, MP 162.38	M
CS40W.21	40W-14	L49	191	196	West Flagstaff Pavement Improvements	A	-Rehabilitate pavement	P
						B	-Replace pavement	M
CS40W.22	40W-14	L53	192	192	West Flagstaff TI EB #1128	A	-Rehabilitate bridge - re-evaluate FY2019 deck rehab project	P
						B	-Replace bridge - re-evaluate FY2019 deck rehab project	M
CS40W.23	40W-14	L54	193	193	Flag Ranch TI EB Bridge #2027	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.24	40W-14	L56	194	194	Woody Mountain Road WB Bridge #1133	A	-Rehabilitate bridge	P
						B	-Replace bridge	M
CS40W.25	40W-2	L4	41	42	Griffith Area Pavement Improvements	A	-Rehabilitate pavement	P
						B	-Replace pavement	M

* '-': indicates only one solution is being proposed and no options are being considered

Figure 23: Candidate Solutions



I-40 West Corridor Profile Study: MP 0 to MP 196
Candidate Solutions

5.0 SOLUTION EVALUATION AND PRIORITIZATION

Candidate solutions are evaluated using the following steps: LCCA (where applicable), Performance Effectiveness Evaluation, Solution Risk Analysis, and Candidate Solution Prioritization. The methodology and approach to this evaluation are shown in **Figure 24** and described more fully below.

Life-Cycle Cost Analysis

All Pavement and Bridge candidate solutions have two options: rehabilitation/repair or reconstruction. These options are evaluated through an LCCA to determine the best approach for each location where a Pavement or Bridge solution is recommended. The LCCA can eliminate options from further consideration and identify which options should be carried forward for further evaluation.

When multiple independent candidate solutions are developed for Mobility, Safety, or Freight strategic investment areas, these candidate solution options advance directly to the Performance Effectiveness Evaluation without an LCCA.

Performance Effectiveness Evaluation

After completing the LCCA process, all remaining candidate solutions are evaluated based on their performance effectiveness. This process includes determining a Performance Effectiveness Score (PES) based on how much each solution impacts the existing performance and needs scores for each segment. This evaluation also includes a Performance Area Risk Analysis to help differentiate between similar solutions based on factors that are not directly addressed in the performance system.

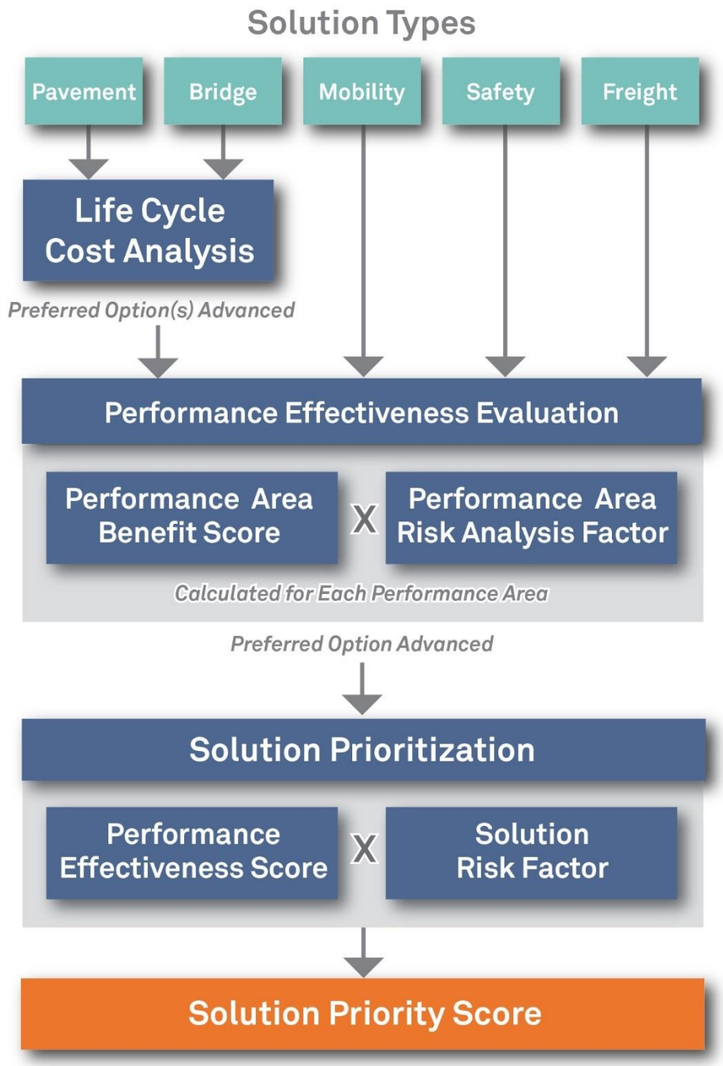
Solution Risk Analysis

All candidate solutions advanced through the Performance Effectiveness Evaluation are also evaluated through a Solution Risk Analysis process. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure.

Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score. The candidate solutions are ranked by prioritization score from highest to lowest. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Solutions that address multiple performance areas tend to score higher in this process.

Figure 24: Candidate Solution Evaluation Process



5.1 Life-Cycle Cost Analysis

LCCA is conducted for any candidate solution that is developed as a result of a need in the Pavement or Bridge performance area. The intent of the LCCA is to determine which options warrant further investigation and eliminate options that would not be considered strategic.

LCCA is an economic analysis that compares cost streams over time and presents the results in a common measure, the present value of all future costs. The cost stream occurs over an analysis period that is long enough to provide a reasonably fair comparison among alternatives that may differ significantly in scale of improvement actions over shorter time periods. For both bridge and pavement LCCA, the costs are focused on agency (ADOT) costs for corrective actions to meet the objective of keeping the bridge or pavement serviceable over a long period of time.

LCCA is performed to provide a more complete holistic perspective on asset performance and agency costs over the life of an investment stream. This approach helps ADOT look beyond initial and short-term costs, which often dominate the considerations in transportation investment decision making and programming.

Bridge LCCA

For the bridge LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected bridges, as described below:

- Bridge replacement (large upfront cost but small ongoing costs afterwards)
- Bridge rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- On-going repairs until replacement (low upfront and ongoing costs until replacement)

The bridge LCCA model developed for the CPS reviews the characteristics of the candidate bridges including bridge ratings and deterioration rates to develop the three improvement strategies (full replacement, rehabilitation until replacement, and repair until replacement). Each strategy consists of a set of corrective actions that contribute to keeping the bridge serviceable over the analysis period. Cost and effect of these improvement actions on the bridge condition are essential parts of the model. Other considerations in the model include bridge age, elevation, pier height, length-to-span ratio, skew angle, and substandard characteristics such as shoulders and vehicle clearance. The following assumptions are included in the bridge LCCA model:

- The bridge LCCA only addresses the structural condition of the bridge and does not address other issues or costs
- The bridge will require replacement at the end of its 75-year service life regardless of current condition
- The bridge elevation, pier height, skew angle, and length-to-span ratio can affect the replacement and rehabilitation costs
- The current and historical ratings are used to estimate a rate of deterioration for each candidate bridge
- Following bridge replacement, repairs will be needed every 20 years
- Different bridge repair and rehabilitation strategies have different costs, expected service life, and benefit to the bridge rating
- The net present value of future costs is discounted at 3% and all dollar amounts are in 2015 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation or repair will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 19**, LCCA was conducted on nine bridges on the I-40 West corridor. A summary of this analysis is shown in **Table 20**. Additional information regarding the bridge LCCA is included in **Appendix E**.

Pavement LCCA

The LCCA approach to pavement is very similar to the process used for bridges. For the pavement LCCA, three basic strategies are analyzed that differ in timing and scale of improvement actions to maintain the selected pavement, as described below:

- Pavement replacement (large upfront cost but small ongoing costs afterwards – could be replacement with asphalt or concrete pavement)
- Pavement major rehabilitation until replacement (moderate upfront costs then small to moderate ongoing costs until replacement)
- Pavement minor rehabilitation until replacement (low upfront and ongoing costs until replacement)

The pavement LCCA model developed for the CPS reviews the characteristics of the candidate paving locations including the historical rehabilitation frequency to develop potential improvement strategies (full replacement, major rehabilitation until replacement, and minor rehabilitation until replacement, for either concrete or asphalt, as applicable). Each strategy consists of a set of corrective actions that contribute to keeping the pavement serviceable over the analysis period. The following assumptions are included in the pavement LCCA model:

- The pavement LCCA only addresses the condition of the pavement and does not address other issues or costs
- The historical pavement rehabilitation frequencies at each location are used to estimate future rehabilitation frequencies
- Different pavement replacement and rehabilitation strategies have different costs and expected service life

- The net present value of future costs is discounted at 3% and all dollar amounts are in 2015 dollars
- If the LCCA evaluation recommends rehabilitation or repair, the solution is not considered strategic and the rehabilitation will be addressed by normal programming processes
- Because this LCCA is conducted at a planning level, and due to the variabilities in costs and improvement strategies, the LCCA net present value results that are within 15% should be considered equally; in such a case, the solution should be carried forward as a strategic replacement project – more detailed scoping will confirm if replacement or rehabilitation is needed

Based on the candidate solutions presented in **Table 19**, LCCA was conducted for three pavement sections on the I-40 West corridor. A summary of this analysis is shown in **Table 21**. Additional information regarding the pavement LCCA is contained in **Appendix E**.

As shown in **Table 20** and **Table 21**, the following conclusions were determined based on the LCCA:

- Rehabilitation or repair was determined to be the most effective approach for the candidate solutions listed below; it is assumed that these identified needs will be addressed by normal programming processes so these solutions were not carried forward to the Performance Effectiveness Evalution:
    - Johnson Canyon WB Bridge #441 (CS40W.16)
    - West Flagstaff TI EB #1128 (CS40W.22)
    - Flag Ranch TI EB Bridge #2027 (CS40W.23)
    - Woody Mountain Road WB Bridge #1133 (CS40W.24)
    - Griffith Area Pavement Improvements (CS40W.25)
- Replacement or reconstruction was determined to be the most effective approach for the candidate solutions listed below; the replacement/reconstruction option of these solutions was carried forward to the Performance Effectiveness Evaluation:
    - Topock Area Pavement Improvements (CS40W.2)
    - Franconia Wash WB Bridge #377 (CS40W.4)
    - Illavar Wash EB Bridge #1310 (CS40W.5)
    - Flat Top Wash WB Bridge #1312 (CS40W.6)
    - Griffith Wash WB Bridge #1658 (CS40W.7)
    - Anvil Rock Road TI UP Bridge #1610 (CS40W.15)
    - West Flagstaff Area Pavement Improvements (CS40W.21)

Table 20: Bridge Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)			Ratio of Present Value Compared to Lowest Present Value			Other Needs	Results
	Replace	Rehab	Repair	Replace	Rehab	Repair		
Anvil Rock Rd TI UP #1610 (CS40W.15, MP 109)	**$2,134,000**	$2,611,000	$2,265,000	1.00	1.22	1.06	No	Strategic solution – Replacement is lowest cost and is recommended
Flag Ranch TI EB #2027 (CS40W.23, MP 192)	$2,054,000	$1,777,000	**$1,412,000**	1.46	1.26	1.00	No	Not strategic solution alone – Rehabilitation is recommended
Flat Top Wash WB #1312 (CS40W.6, MP 21)	$2,636,000	**$2,274,000**	$2,369,000	1.16	1.00	1.04	No	Service life complete by 2030 – Replacement is recommended
Franconia Wash WB #377 (CS40W.4, MP 13)	$2,408,000	**$2,077,000**	$2,185,000	1.16	1.00	1.05	No	Service life complete by 2030 – Replacement is recommended
Griffith Wash WB #1658 (CS40W.7, MP 40)	$2,219,000	**$2,031,000**	$2,135,000	1.09	1.00	1.05	No	Service life complete by 2030 and Replacement is within 15% of lowest cost – Replacement is recommended
Illavar Wash EB #1310 (CS40W.5, MP 18)	$2,388,000	**$2,186,000**	$2,290,000	1.09	1.00	1.05	No	Service life complete by 2030 and Replacement is within 15% of lowest cost – Replacement is recommended
Johnson Canyon WB #441 (CS40W.16, MP 148)	$953,000	$1,180,000	**$790,000**	1.21	1.49	1.00	No	Not strategic solution alone – Rehabilitation is recommended
West Flagstaff TI EB #1128 (CS40W.22, MP 192)	$1,988,000	$1,696,000	**$1,299,000**	1.53	1.31	1.00	No	Not strategic solution alone – Rehabilitation is recommended
Woody Mountain Rd WB #1133 (CS40W.24, MP 194)	$2,054,000	$1,730,000	**$1,299,000**	1.58	1.33	1.00	No	Not strategic solution alone – Rehabilitation is recommended

Table 21: Pavement Life-Cycle Cost Analysis Results

Candidate Solution	Present Value at 3% Discount Rate ($)				Ratio of Present Value Compared to Lowest Present Value				Other Needs	Results
	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation	Concrete Reconstruction	Asphalt Reconstruction	Asphalt Medium Rehabilitation	Asphalt Light Rehabilitation		
Topock Area Pavement Improvements (CS40W.2, MP 3-8)	$43,978,000	$40,262,000	**$37,767,000**	$39,808,000	1.16	1.07	1.00	1.05	No	Asphalt reconstruction is within 15% of lowest cost - Replacement is recommended
West Flagstaff Area Pavement Improvements (CS40W.21, MP 191-196)	**$45,235,000**	$47,395,000	$45,980,000	$49,272,000	1.00	1.03	1.02	1.09	No	Concrete reconstruction is the lowest option and asphalt reconstruction is within 15% of the lowest rehabilitation cost - Replacement is recommended
Griffith Area Pavement Improvements (CS40W.25, MP 41-42)	$4,398,000	$4,027,000	**$3,419,000**	$3,518,000	1.29	1.18	1.00	1.03	No	Reconstruction is not within 15% of lowest cost - Rehabilitation is recommended

5.2 Performance Effectiveness Evaluation

The results of the Performance Effectiveness Evaluation are combined with the results of a Performance Area Risk Analysis to determine a Performance Effectiveness Score (PES). The objectives of the Performance Effectiveness Evaluation include:

- Measure the benefit to the performance system versus the cost of the solution
- Include risk factors to help differentiate between similar solutions
- Apply to each performance area that is affected by the candidate solution
- Account for emphasis areas identified for the corridor

The Performance Effectiveness Evaluation includes the following steps:

- Estimate the post-solution performance for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight)
- Use the post-solution performance scores to calculate a post-solution level of need for each of the five performance areas
- Compare the pre-solution level of need to the post-solution level of need to determine the reduction in level of need (potential solution benefit) for each of the five performance areas
- Calculate performance area risk weighting factors for each of the five performance areas
- Use the reduction in level of need (benefit) and risk weighting factors to calculate the PES

Post-Solution Performance Estimation

For each performance area, a slightly different approach is used to estimate the post-solution performance. This process is based on the following assumptions:

- Pavement:
  - The IRI rating would decrease (to 30 for replacement or 45 for rehabilitation)
  - The Cracking rating would decrease (to 0 for replacement or rehabilitation)
- Bridge:
  - The structural ratings would increase (+1 for repair, +2 for rehabilitation, or increase to 8 for replacement)
  - The Sufficiency Rating would increase (+10 for repair, +20 for rehabilitation, or increase to 98 for replacement)
- Mobility:
  - Additional lanes would increase the capacity and therefore affect the Mobility Index and associated secondary measures
  - Other improvements (e.g., ramp metering, parallel ramps, variable speed limits) would also increase the capacity (to a lesser extent than additional lanes) and therefore would affect the Mobility Index and associated secondary measures
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTI secondary measure
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the PTI secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Extent secondary measure
- Safety:
  - Crash modification factors were developed that would be applied to estimate the reduction in crashes (for additional information see **Appendix F**)
- Freight:
  - Changes in the Mobility Index (due to increased capacity) and Safety Index (due to crash reductions) would have a direct effect on the Freight Index and the TPTI secondary measure
  - Changes in the Mobility Index (due to increased capacity) would have a direct effect on the TTTI secondary measure
  - Changes in the Safety Index (due to crash reductions) would have a direct effect on the Closure Duration secondary measure

Performance Area Risk Analysis

The Performance Area Risk Analysis is intended to develop a numeric risk weighting factor for each of the five performance areas (Pavement, Bridge, Mobility, Safety, and Freight). This risk analysis addresses other considerations for each performance area that are not directly included in the performance system. A risk weighting factor is calculated for each candidate solution based on the specific characteristics at the solution location. For example, the Pavement Risk Factor is based on factors such as the elevation, daily traffic volumes, and amount of truck traffic. Additional information regarding the Performance Area Risk Factors is included in **Appendix G**.

Following the calculation of the reduction in level of need (benefit) and the Performance Area Risk Factors, these values are used to calculate the PES. In addition, the reduction in level of need in each emphasis area is also included in the PES.

Net Present Value Factor

The benefit (reduction in need) is measured as a one-time benefit. However, different types of solutions will have varying service lives during which the benefits will be obtained. For example, a preservation solution would likely have a shorter stream of benefits over time when compared to a modernization or expansion solution. To address the varying lengths of benefit streams, each solution is classified as a 10-year, 20-year, 30-year, or 75-year benefit stream, or the net present value (NPV) factor (F_{NPV}). A 3% discount rate is used to calculate F_{NPV} for each classification of solution. The service lives and respective factors are described below:

- A 10-year service life is generally reflective of preservation solutions such as pavement and bridge preservation; these solutions would likely have a 10-year stream of benefits; for these solutions, a F_{NPV} of 8.8 is used in the PES calculation

- A 20-year service life is generally reflective of modernization solutions that do not include new infrastructure; these solutions would likely have a 20-year stream of benefits; for these solutions, a F_{NPV} of 15.3 is used in the PES calculation
- A 30-year service life is generally reflective of expansion solutions or modernization solutions that include new infrastructure; these solutions would likely have a 30-year stream of benefits; for these solutions, a F_{NPV} of 20.2 is used in the PES calculation
- A 75-year service life is used for bridge replacement solutions; these solutions would likely have a 75-year stream of benefits; for these solutions, a F_{NPV} of 30.6 is used in the PES calculation

Vehicle-Miles Travelled Factor

Another factor in assessing benefits is the number of travelers who would benefit from the implementation of the candidate solution. This factor varies between candidate solutions depending on the length of the solution and the magnitude of daily traffic volumes. Multiplying the solution length by the daily traffic volume results in vehicle-miles travelled (VMT), which provides a measure of the amount of traffic exposure that would receive the benefit of the proposed solution. The VMT is converted to a VMT factor (known as F_{VMT}), which is on a scale between 0 and 5, using the equation below:

$$F_{VMT} = 5 - (5 \times e^{VMT \times -0.0000139})$$

Performance Effectiveness Score

The PES is calculated using the following equation:

PES = ((Sum of all Risk Factored Benefit Scores + Sum of all Risk Factored Emphasis Area Scores) / Cost) x F_{VMT} x F_{NPV}

Where:

Risk Factored Benefit Score = Reduction in Segment-Level Need (benefit) x Performance Area Risk Weighting Factor (calculated for each performance area)

Risk Factored Emphasis Area Score = Reduction in Corridor-Level Need x Performance Area Risk Factors x Emphasis Area Factor (calculated for each emphasis area)

*Cost = estimated cost of candidate solution in millions of dollars (see **Appendix H**)*

F_{VMT} = Factor between 0 and 5 to account for VMT at location of candidate solution based on existing (2014) daily volume and length of solution

F_{NPV} = Factor (ranging from 8.8 to 30.6 as previously described) to address anticipated longevity of service life (and duration of benefits) for each candidate solution

The resulting PES values are shown in **Table 22**. Additional information regarding the calculation of the PES is contained in **Appendix I**.

For candidate solutions with multiple options to address Mobility, Safety, or Freight needs, the PES should be compared to help identify the best performing option. If one option clearly performs better than the other options (e.g., more than twice the PES value and a difference in magnitude of at least 20 points), the other options can be eliminated from further consideration. If multiple options have similar PES values, or there are other factors not accounted for in the performance system that could significantly influence the ultimate selection of an option (e.g., potential environmental concerns, potential adverse economic impacts), those options should all be advanced to the prioritization process. On the I-40 West corridor, no candidate solutions have options to address Mobility, Safety, or Freight needs.

As was previously mentioned, rehabilitation or repair (Option A) was determined to be the most effective approach for the candidate solutions listed below that were subject to LCCA so these candidate solutions were eliminated from further consideration; no PES values were calculated for these solutions and they do not appear in **Table 22**:

- Johnson Canyon WB #441 (CS40W.16, MP 148)
- West Flagstaff TI EB #1128 (CS40W.22, MP 192)
- Flag Ranch TI EB #2027 (CS40W.23, MP 192)
- Woody Mountain Rd WB #1133 (CS40W.24, MP 194)
- Griffith Area Pavement Improvements (CS40W.25, MP 41-42)

Replacement or reconstruction (Option B) was determined to be the most effective approach for the candidate solutions listed below that were subject to LCCA so these candidate solutions were carried forward to the Performance Effectiveness Evaluation and PES values were calculated for these solutions as shown in **Table 22**:

- Anvil Rock Rd TI UP #1610 (CS40W.15, MP 109)
- Flat Top Wash WB #1312 (CS40W.6, MP 21)
- Franconia Wash WB #377 (CS40W.4, MP 13)
- Griffith Wash WB #1658 (CS40W.7, MP 40)
- Illavar Wash EB #1310 (CS40W.5, MP 18)
- Topock Area Pavement Improvements (CS40W.2, MP 3-8)
- West Flagstaff Area Pavement Improvements (CS40W.21, MP 191-196)

Table 22: Performance Effectiveness Scores

Candidate Solution #	Segment #	Candidate Solution Name	Milepost Location	Estimated Cost* (in millions)	Risk Factored Benefit Score					Risk Factored Emphasis Area Scores			Total Factored Benefit Score	F_{VMT}	F_{NPV}	Performance Effectiveness Score
					Pavement	Bridge	Mobility	Safety	Freight	Pavement	Bridge	Safety				
CS40W.1	40W-1	Colorado River Bridge #957	0	$55.0	0.00	10.64	0.00	0.00	0.00	0.00	1.09	0.00	11.73	1.01	30.6	6.6
CS40W.2	40W-1	Topock Area Pavement Improvements - Replacement	3-8	$35.9	0.16	0.00	0.09	0.31	0.08	0.34	0.00	0.02	0.99	2.98	20.2	1.7
CS40W.3	40W-1	Stateline to SR 95 Safety Improvements	0-11	$6.2	0.00	0.00	0.38	1.31	0.09	0.00	0.00	0.07	1.86	4.32	15.3	19.8
CS40W.4	40W-2	Franconia Wash WB Bridge #377 - Replacement	13	$2.3	0.00	1.34	0.00	0.00	0.00	0.00	0.05	0.00	1.39	0.46	30.6	8.4
CS40W.5	40W-2	Illavar Wash EB Bridge #1310 - Replacement	18	$1.2	0.00	1.08	0.00	0.00	0.00	0.00	0.04	0.00	1.11	0.45	30.6	12.9
CS40W.6	40W-2	Flat Top Wash WB Bridge #1312 - Replacement	21	$2.0	0.00	1.28	0.00	0.00	0.00	0.00	0.05	0.00	1.33	0.46	30.6	9.2
CS40W.7	40W-2	Griffith Wash WB Bridge #1658 - Replacement	40	$2.0	0.00	1.39	0.00	0.00	0.00	0.00	0.06	0.00	1.45	0.46	30.6	10.3
CS40W.8	40W-2	SR 95 to Kingman Safety Improvements	11-43	$18.0	0.00	0.00	0.04	0.61	0.03	0.00	0.00	0.16	0.84	4.99	15.3	3.6
CS40W.9	40W-3	Kingman Area Safety Improvements	43-55	$29.0	0.00	0.00	1.92	2.26	1.51	0.00	0.00	0.12	5.81	4.85	15.3	14.9
CS40W.10	40W-3	Kingman Area Climbing Lane	47-51	$25.6	0.00	0.00	0.36	0.25	0.23	0.00	0.00	0.02	0.86	2.21	20.2	1.5
CS40W.11	40W-4	Kingman to US 93 Safety and Freight Improvements	58-71	$46.4	0.00	0.00	0.53	0.27	1.33	0.00	0.00	0.03	2.16	4.77	15.3	3.4
CS40W.12	40W-4	Kingman to US 93 Area Climbing Lane	58-60	$7.5	0.00	0.00	0.05	0.15	0.18	0.00	0.00	0.02	0.40	1.06	20.2	1.1
CS40W.13	40W-6	Willow Creek Safety Improvements	80-97	$50.0	0.00	0.00	0.60	0.45	0.45	0.00	0.00	0.05	1.55	2.62	20.2	1.6
CS40W.14	40W-7	Jolly Road Area Safety Improvements	98-108	$13.2	0.00	0.00	0.23	2.06	0.28	0.00	0.00	0.11	2.67	4.17	15.3	13.0
CS40W.15	40W-8	Anvil Rock Rd TI UP Bridge # 1610 - Replacement	110	$2.8	0.00	4.52	0.00	0.00	0.00	0.00	0.27	0.00	4.79	0.19	30.6	9.8
CS40W.17	40W-10	Ash Fork to Williams Safety and Freight Improvements	143-160	$29.6	0.00	0.00	2.05	4.00	3.34	0.00	0.00	0.39	9.77	4.83	15.3	24.4
CS40W.18	40W-10	Ash Fork to Williams Area Climbing Lane	151-159	$22.8	0.00	0.00	0.26	0.06	0.13	0.00	0.00	0.01	0.46	1.65	20.2	0.7
CS40W.19	40W-11	Williams Area Safety Improvements	160-168	$11.6	0.00	0.00	0.36	0.60	0.17	0.00	0.00	0.10	1.22	4.13	15.3	6.6
CS40W.20	40W-11	Williams Area Climbing Lane	162-163	$5.6	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.52	20.2	1.0
CS40W.21	40W-14	West Flagstaff Pavement Improvements - Replacement	191-196	$43.2	2.16	0.00	0.02	0.02	0.02	0.40	0.00	0.00	2.62	4.26	20.2	5.2

* see Table 24 for total construction costs

5.3 Solution Risk Analysis

Following the calculation of the PES, an additional step is taken to develop the prioritized list of solutions. A solution risk probability and consequence analysis is conducted to develop a solution-level risk weighting factor. This risk analysis is a numeric scoring system to help address the risk of not implementing a solution based on the likelihood and severity of performance failure. **Figure 25** shows the risk matrix used to develop the risk weighting factors.

Figure 25: Risk Matrix

		Severity/Consequence				
		Insignificant	**Minor**	**Significant**	**Major**	**Catastrophic**
Frequency/ Likelihood	**Very Rare**	Low	Low	Low	Moderate	Major
	Rare	Low	Low	Moderate	Major	Major
	Seldom	Low	Moderate	Moderate	Major	Severe
	Common	Moderate	Moderate	Major	Severe	Severe
	Frequent	Moderate	Major	Severe	Severe	Severe

Using the risk matrix in **Figure 25**, numeric values were assigned to each category of frequency and severity. The higher the risk, the higher the numeric factor that was assigned. The risk weight for each area of the matrix was calculated by multiplying the severity factor times the frequency factor. These numeric factors are shown in **Figure 26**.

Figure 26: Numeric Risk Matrix

			Severity/Consequence				
			Insignificant	**Minor**	**Significant**	**Major**	**Catastrophic**
		Weight	1.00	1.10	1.20	1.30	1.40
Frequency/ Likelihood	**Very Rare**	1.00	1.00	1.10	1.20	1.30	1.40
	Rare	1.10	1.10	1.21	1.32	1.43	1.54
	Seldom	1.20	1.20	1.32	1.44	1.56	1.68
	Common	1.30	1.30	1.43	1.56	1.69	1.82
	Frequent	1.40	1.40	1.54	1.68	1.82	1.96

Using the values in **Figure 26**, risk weighting factors were calculated for each of the following four risk categories: low, moderate, major, and severe. These values are simply the average of the values in **Figure 26** that fall within each category. The resulting average risk weighting factors are:

Low	Moderate	Major	Severe
1.14	1.36	1.51	1.78

The risk weighting factors listed above are assigned to the five performance areas as follows:

- Safety = 1.78
  - The Safety performance area quantifies the likelihood of fatal or incapacitating injury crashes; therefore, it is assigned the Severe (1.78) risk weighting factor
- Bridge = 1.51
  - The Bridge performance area focuses on the structural adequacy of bridges; a bridge failure may result in crashes or traffic being detoured for long periods of time resulting in significant travel time increases; therefore, it is assigned the Major (1.51) risk weighting factor
- Mobility and Freight = 1.36
  - The Mobility and Freight performance areas focus on capacity and congestion; failure in either of these performance areas would result in increased travel times but would not have significant effect on safety (crashes) that would not already be addressed in the Safety performance area; therefore, they are assigned the Moderate (1.36) risk weighing factor
- Pavement = 1.14
  - The Pavement performance area focuses on the ride quality of the pavement; failure in this performance area would likely be a spot location that would not dramatically affect drivers beyond what is already captured in the Safety performance area; therefore, it is assigned the Low (1.14) risk weighting factor

The benefit in each performance area is calculated for each candidate solution as part of the Performance Effectiveness Evaluation. Using this information on benefits and the risk factors listed above, a weighted (based on benefit) solution-level numeric risk factor is calculated for each candidate solution. For example, a solution that has 50% of its benefit in Safety and 50% of its benefit in Mobility has a weighted risk factor of 1.57 (0.50 x 1.36 + 0.50 x 1.78 = 1.57).

5.4 Candidate Solution Prioritization

The PES, weighted risk factor, and segment average need score are combined to create a prioritization score as follows:

Prioritization Score = PES x Weighted Risk Factor x Segment Average Need Score

Where:

*PES = Performance Effectiveness Score as shown in **Table 22***

Weighted Risk Factor = Weighted factor to address risk of not implementing a solution based on the likelihood and severity of the performance failure

*Segment Average Need Score = Segment average need score as shown in **Table 17***

Table 23 shows the prioritization scores for the candidate solutions subjected to the solution evaluation and prioritization process. Solutions that address multiple performance areas tend to score higher in this process. A prioritized list of candidate solutions is provided in the subsequent section. See **Appendix J** for additional information on the prioritization process.

Table 23: Prioritization Scores

Candidate Solution #	Segment #	Candidate Solution Name	Milepost Location	Estimated Cost (in millions)	Performance Effectiveness Score	Weighted Risk Factor	Segment Average Need Score	Prioritization Score	Percentage by which Solution Reduces Performance Area Segment Needs				
									Pavement	Bridge	Mobility	Safety	Freight
CS40W.1	40W-1	Colorado River Bridge #957	0	$55.0	6.6	1.51	1.92	**19**		100%			
CS40W.2	40W-1	Topock Area Pavement Improvements - Replacement	3-8	$35.9	1.7	1.39	1.92	**4**	100%		4%	12%	6%
CS40W.3	40W-1	Stateline to SR 95 Safety Improvements	0-11	$6.2	19.8	1.67	1.92	**64**			14%	53%	7%
CS40W.4	40W-2	Franconia Wash WB Bridge #377 - Replacement	13	$2.3	8.4	1.51	1.23	**16**		38%			
CS40W.5	40W-2	Illavar Wash EB Bridge #1310 - Replacement	18	$1.2	12.9	1.51	1.23	**24**		34%			
CS40W.6	40W-2	Flat Top Wash WB Bridge #1312 - Replacement	21	$2.0	9.2	1.51	1.23	**17**		36%			
CS40W.7	40W-2	Griffith Wash WB Bridge #1658 - Replacement	40	$2.0	10.3	1.51	1.23	**19**		39%			
CS40W.8	40W-2	SR 95 to Kingman Safety Improvements	11-43	$18.0	3.6	1.75	1.23	**8**			1%	34%	2%
CS40W.9	40W-3	Kingman Area Safety Improvements	43-55	$29.0	14.9	1.53	1.23	**28**			34%	70%	52%
CS40W.10	40W-3	Kingman Area Climbing Lane	47-51	$25.6	1.5	1.49	1.23	**3**			8%	8%	8%
CS40W.11	40W-4	Kingman to US 93 Safety and Freight Improvements	58-71	$47.7	3.4	1.42	1.38	**7**			12%	6%	19%
CS40W.12	40W-4	Kingman to US 93 Area Climbing Lane	58-60	$7.5	1.1	1.54	1.38	**2**			1%	3%	3%
CS40W.13	40W-6	Willow Creek Safety Improvements	80-97	$51.2	1.6	1.50	1.46	**4**			15%	11%	9%
CS40W.14	40W-7	Jolly Road Area Safety Improvements	98-108	$14.5	13.0	1.70	0.77	**17**			9%	70%	10%
CS40W.15	40W-8	Anvil Rock Rd TI UP Bridge # 1610 - Replacement	110	$2.8	9.8	1.51	1.23	**18**		100%			
CS40W.17	40W-10	Ash Fork to Williams Safety and Freight Improvements	143-160	$30.3	24.4	1.55	1.54	**58**			22%	40%	19%
CS40W.18	40W-10	Ash Fork to Williams Area Climbing Lane	151-159	$22.8	0.7	1.42	1.54	**1**			4%	1%	1%
CS40W.19	40W-11	Williams Area Safety Improvements	160-168	$12.3	6.6	1.60	1.69	**18**			14%	23%	5%
CS40W.20	40W-11	Williams Area Climbing Lane	162-163	$5.6	1.0	1.36	1.69	**1**			1%		
CS40W.21	40W-14	West Flagstaff Pavement Improvements - Replacement	191-196	$43.2	5.2	1.15	1.00	**6**	51%		1%	4%	1%

6.0 SUMMARY OF CORRIDOR RECOMMENDATIONS

6.1 Prioritized Candidate Solution Recommendations

Table 24 and **Figure 27** show the prioritized candidate solutions recommended for the I-40 West corridor in ranked order of priority. The highest prioritization score indicates the candidate solution that is recommended as the highest priority. Implementation of these solutions is anticipated to improve performance of the I-40 West corridor. The following observations were noted about the prioritized solutions:

- Most of the anticipated improvements in performance are in the Mobility, Safety, and Freight performance areas
- The highest-ranking solutions tend to have overlapping benefits in the Mobility, Safety, and Freight performance areas
- The highest priority solutions address needs in the Stateline to Kingman area (MP 0-55) and Ash Fork to Williams area (MP 143-160)

6.2 Other Corridor Recommendations

As part of the investigation of strategic investment areas and candidate solutions, other corridor recommendations can also be identified. These recommendations could include modifications to the existing Statewide Construction Program, areas for further study, or other corridor-specific recommendations that are not related to construction or policy. The list below identifies other corridor recommendations for the I-40 West corridor:

- Expand the limits of the programmed pavement rehabilitation project in FY 2019 at MP 108-123 to also include MP 123-124 to address the pavement hot spot at MP 123-124
- Expand the limits of the programmed pavement rehabilitation project in FY 2018 at MP 162-179 to also include MP 160-162 to address the pavement hot spot at MP 160-161
- Expand the scope of the programmed bridge deck rehabilitation project in FY 2019 at the W Flagstaff TI WB Bridge #1129 at MP 192 to also include bridge superstructure rehabilitation to address the low superstructure rating at this bridge
- Conduct an interchange operations study for the I-40/SR 95 interchange near MP 10
- Promote planned construction of I-40/US 93 system interchange near MP 49

6.3 Policy and Initiative Recommendations

In addition to location-specific needs, general corridor and system-wide needs have also been identified through the CPS process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them. A list of recommended policies and initiatives was developed for consideration when programming future projects not only on the I-40 West corridor, but across the entire state highway system where the conditions are applicable. The following list, which is in no particular order of priority, was derived from the Round 1, Round 2, and Round 3 CPS:

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic message signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project
- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16.25 feet where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent; additional coordination for data on tribal lands is required to ensure adequate reflection of safety issues
- Expand data collection devices statewide to measure freight delay
- Evaluate and accommodate potential changes in freight and goods movement trends that may result from improvements and expansions to the state roadway network

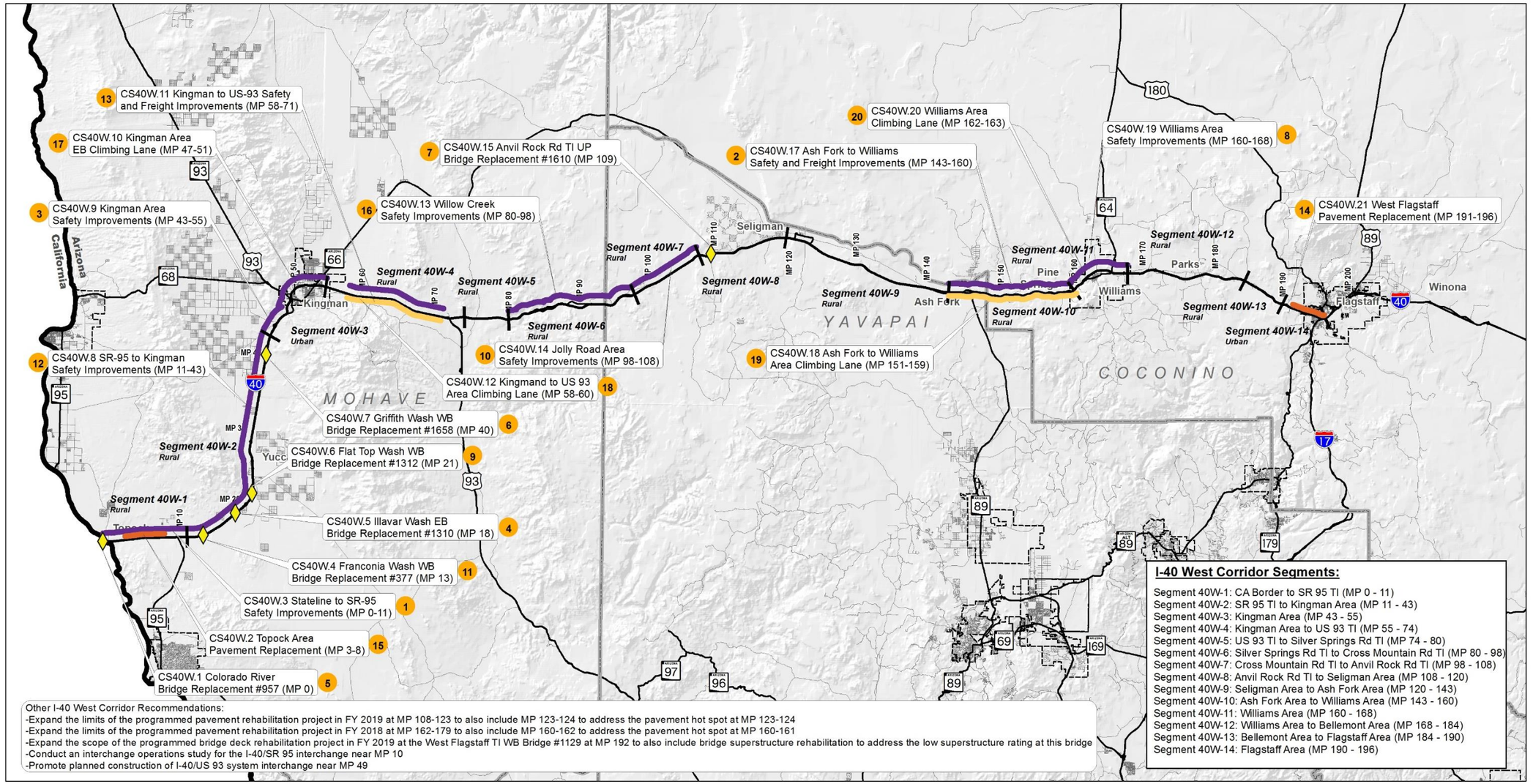
Table 24: Prioritized Recommended Solutions

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
1	CS40W.3	Stateline to SR 95 Safety Improvements (MP 0-11)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips)	$6.2	M	**64**
2	CS40W.17	Ash Fork to Williams Safety and Freight Improvements (MP 143-160)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 151-159 and integrate with existing RWIS at MP 154 and MP 159 and existing DMS at EB MP 144 and with new DMS at WB MP 160	$30.3	M	**58**
3	CS40W.9	Kingman Area Safety Improvements (MP 43-55)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Install median cable barrier at MP 47-51 -Implement VSL at EB/WB MP 47-53 and integrate with existing DMS at EB MP 45 and WB MP 55	$29.0	M	**28**
4	CS40W.5	Illavar Wash EB Bridge #1310 - Replacement (MP 18.30)	-Replace bridge	$1.2	M	**24**
5	CS40W.1	Colorado River Bridge #957 (MP 0)	-Continue coordinating with Caltrans for programming Colorado River Bridge deck replacement; Cost reflects ADOT's anticipated share of costs	$55.0	M	**19**
6	CS40W.7	Griffith Wash WB Bridge #1658 - Replacement (MP 40.42)	-Replace bridge	$2.0	M	**19**
7	CS40W.15	Anvil Rock Rd TI UP Bridge # 1610 - Replacement (MP 108.65)	-Replace bridge	$2.8	M	**18**
8	CS40W.19	Williams Area Safety Improvements (MP 160-168)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 161-163 and integrate with existing RWIS at MP 159 and existing DMS at WB MP 168 and with new DMS at EB MP 160	$12.3	M	**18**
9	CS40W.6	Flat Top Wash WB Bridge #1312 - Replacement (MP 21.01)	-Replace bridge	$2.0	M	**17**
10	CS40W.14	Jolly Road Area Safety Improvements (MP 98-108)	-Rehabilitate shoulder (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Implement VSL at EB/WB MP 101-104 and integrate with new RWIS at MP 103 and new DMS at EB MP 100 and WB MP 105	$14.5	M	**17**
11	CS40W.4	Franconia Wash WB Bridge #377 - Replacement (MP 13.61)	-Replace bridge	$2.3	M	**16**
12	CS40W.8	SR 95 to Kingman Safety Improvements (MP 11-43)	-Rehabilitate shoulders (includes new striping, delineators, raised pavement markers, safety edge and rumble strips) -Provide signs for driver information (advance notice of rest area)	$18.0	M	**8**
13	CS40W.11	Kingman to US 93 Safety and Freight Improvements (MP 58-71)	-Implement VSL at EB/WB MP 58-71 and integrate with existing DMS at EB MP 69 and with new DMS at EB MP 55 and WB MP 72	$47.7	M	**7**
14	CS40W.21	West Flagstaff Pavement Improvements - Replacement (MP 191-196)	-Replace pavement	$43.2	M	**6**

Table 24: Prioritized Recommended Solutions (continued)

Rank	Candidate Solution #	Candidate Solution Name	Candidate Solution Scope	Estimated Cost (in millions)	Investment Category (Preservation [P], Modernization [M], Expansion [E])	Prioritization Score
15	CS40W.2	Topock Area Pavement Improvements - Replacement (MP 3-8)	-Replace pavement	$35.9	M	**4**
16	CS40W.13	Willow Creek Safety Improvements (MP 80-98)	-Construct EB climbing lane at MP 80-83 and MP 93-97 -Widen Echeverria OP EB bridge #1675, MP 94.45 -Widen Cross Mountain TI OP EB bridge #1677, MP 96.02 -Implement VSL at EB MP 80-83, EB MP 88-90, and EB MP 93-97 and integrate with existing RWIS at MP 91 and new DMS at EB MP 79 and WB MP 98	$51.2	M	**4**
17	CS40W.10	Kingman Area Climbing Lane (MP 47-51)	-Construct EB climbing lane MP 47-51 -Widen W Kingman TI OP EB bridge #1835, MP 48.84 -Widen Clack Canyon Wash EB bridge #1837, MP 49.70 -Widen White Cliff Road OP EB bridge #1839, MP 50.09	$25.6	M	**3**
18	CS40W.12	Kingman to US 93 Area Climbing Lane (MP 58-60)	-Construct EB climbing lane at MP 58-60	$7.5	M	**2**
19	CS40W.18	Ash Fork to Williams Area Climbing Lane (MP 151-159)	-Construct EB climbing lane at MP 151-152 and MP 156-159 -Widen Devil Dog TI OP EB bridge #1178, MP 157.71	$22.8	M	**1**
20	CS40W.20	Williams Area Climbing Lane (MP 162-163)	-Construct WB climbing lane at MP 162-163 -Widen SFRR and Cata Lake OP WB bridge #1902, MP 162.38	$5.6	M	**1**

Figure 27: Prioritized Recommended Solutions



6.4 Next Steps

The candidate solutions recommended in this study are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and districts develop candidate projects for consideration in the performance-based programming in the P2P process. Rather, these candidate solutions are intended to complement ADOT's traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Candidate solutions developed for the I-40 West corridor will be considered along with other candidate projects in the ADOT statewide programming process.

It is important to note that the candidate solutions are intended to represent strategic solutions to address existing performance needs related to the Pavement, Bridge, Mobility, Safety, and Freight performance areas. Therefore, the strategic solutions are not intended to preclude recommendations related to the ultimate vision for the corridor that may have been defined in the context of prior planning studies and/or design concept reports. Recommendations from such studies are still relevant to addressing the ultimate corridor objectives.

Upon completion of all three CPS rounds, the results will be incorporated into a summary document comparing all corridors that is expected to provide a performance-based review of statewide needs and candidate solutions.